



LIBRARY
UNIVERSITY OF CALIFORNIA
DAVIS

CHROMITE DEPOSITS OF THE SOUTHERN COAST RANGES OF CALIFORNIA *

BY GEORGE W. WALKER AND ALLAN B. GRIGGS **

OUTLINE OF REPORT

	Page
Abstract	40
Introduction	40
General geology	43
Ultramafic rocks	45
The chromite ore	48
Production and reserves	49
Guides to prospecting	50
Description of the deposits	51
Alameda County	51
Contra Costa, San Francisco, and San Mateo Counties	52
Monterey County	53
San Benito and western Fresno Counties	54
San Luis Obispo County	55
Northern San Luis Obispo County	56
Cerro Alto-Cuesta Pass area	60
Pick and Shovel group	64
Seeley group	65
Sweetwater-Norcross group	65
San Luis Obispo-Arroyo Grande area	68
San Luis Range area	69
Santa Barbara County	69
Santa Clara County	71
Santa Cruz County	73
Stanislaus County	74
References	76
List of chromite deposits	79

Illustrations

	Page
Plate 1. Map of Contra Costa, Alameda, San Francisco, and San Mateo Counties, California, showing location of chromite deposits and distribution of ultramafic rocks	In pocket
2. Map of Santa Clara, Santa Cruz, and Stanislaus Counties, California, showing location of chromite deposits and distribution of ultramafic rocks	In pocket
3. Map of Monterey, San Benito, and western Fresno Counties, California, showing location of chromite deposits and distribution of ultramafic rocks	In pocket
4. Map of western part of San Luis Obispo County, California, showing location of chromite deposits and distribution of ultramafic rocks	In pocket
5. Map of Santa Barbara County, California, showing location of chromite deposits and distribution of ultramafic rocks	In pocket
6. Horizontal projection and sections of ore bodies at the Castro mine, San Luis Obispo County, California	In pocket
7. Map and section of the Trinidad mine, San Luis Obispo County, California	In pocket

* Publication authorized by the Director, U. S. Geological Survey. Manuscript received for publication January 1953.

** Geologists, U. S. Geological Survey.

8. Geologic map of the ultramafic complex of the Red Mountain-Del Puerto area, Santa Clara and Stanislaus Counties, California—	In pocket
Figure 1. Index map showing general area covered by report, and major physiographic features of the southern Coast Ranges of California—	41
2. Sketch map of the Daisy (Aldelabran) chromite deposit—	54
3. Photo of Castro mill at Goldtree Siding—	59
4. Photo of reclaiming dumps at the New London mine—	62
5. Photo of Norcross (Biaggini) mine—	66

ABSTRACT

The chromite deposits of the southern Coast Ranges of California, comprising the deposits in Contra Costa, Alameda, San Francisco, San Mateo, Santa Cruz, Santa Clara, Stanislaus, San Benito, Monterey, western Fresno, San Luis Obispo, and Santa Barbara Counties, had yielded a total of almost 71,000 long tons of chromite ore and concentrates through December 1945. Of this total, more than 62,000 long tons was produced from San Luis Obispo County, placing this county first in rank among chromite-producing counties in California.

The production of chromite from many of the deposits has been less than 100 long tons, but five deposits have yielded more than 2,000 long tons. The largest known production of chromite in the southern Coast Ranges is from the Castro mine in San Luis Obispo County; nearly 29,000 long tons of concentrates and lump ore have been shipped from this property.

All the productive chromite deposits of the southern Coast Ranges occur in two extensive, northwest-trending blocks, or belts, that contain large areas of rocks of the Franciscan formation and associated ultramafic intrusives. One of these blocks lies to the west of the "Nacimiento" fault zone in western Monterey and San Luis Obispo Counties, and the other block lies to the east of the San Andreas fault zone in the counties adjoining San Francisco Bay and southeast through Santa Clara, western Stanislaus, San Benito, and southeastern Monterey Counties. An intervening block, made up largely of crystalline rocks of pre-Franciscan age and Cretaceous and Tertiary sedimentary rocks, contains virtually no Franciscan rocks, ultramafic intrusives, or chromite. The chromite deposits occur only in the ultramafic rocks and in serpentine derived from such rocks.

Most of the chromite ore occurs as pods of massive, crystalline chromite or as disseminated bodies containing dispersed grains of chromite in dunite or peridotite. In many deposits there are intergradations between high-grade massive ore and low-grade disseminated material. Local concentrations of chromite have been developed in beach sands and stream gravels, and as residual weathered lumps on hillsides.

INTRODUCTION

The chromite deposits of the southern Coast Ranges of California, comprising the small deposits in Santa Clara, San Benito, western Fresno, and Santa Barbara Counties and the larger deposits of Alameda, Stanislaus, and San Luis Obispo Counties, had yielded a recorded total of almost 71,000 long tons of chromite ore and concentrates through December 1945. Other occurrences of chromite in San Francisco, Contra Costa, San Mateo, Santa Cruz, and Monterey Counties have yielded no recorded production. San Luis Obispo County has accounted for more than 62,000 long tons, placing it not only far ahead of any other county in the southern Coast Ranges, but also first among chromite-producing counties in California.

Geography. The chromite deposits of the southern Coast Ranges, as considered in this report, are those deposits that occur in the Coast Ranges geomorphic province south of the San Francisco Bay area. A few small deposits, located in areas immediately adjacent on the east to the Coast Ranges geomorphic province, are also considered in this report because their geographic location and geologic environment are closely



FIGURE 1. Index map showing general area covered by report, and major physiographic features of the southern Coast Ranges of California.

related to the deposits of the southern Coast Ranges. Included are the deposits in Alameda, Contra Costa, San Francisco, San Mateo, Stanislaus, and Santa Clara Counties, and, to the south, the deposits in Santa Cruz, San Benito, Monterey, San Luis Obispo, Santa Barbara, and western Fresno Counties.

The southern Coast Ranges are characterized by northwest-trending mountain ranges and intervening valleys, whose physiographic expression is largely controlled by folds and faults. The dominant topographic features of the area are the Diablo Range, which merges into the Temblor Range to the south, the Salinas Valley, and on the west, the Santa Cruz Mountains and the Santa Lucia Range. Maximum relief is nearly 7,000 feet; the highest and most rugged terrain is in the Santa Lucia Range in San Luis Obispo and Monterey Counties.

The counties in the area cover more than 14,500 square miles and have a total population of more than 2,600,000 (1950 census, preliminary estimate) of which more than 2,000,000 are concentrated in the cities near and adjacent to the San Francisco Bay area. Large tracts of land, particularly in the Santa Clara, Salinas, and Santa Maria Valleys, are well-settled and devoted to intensive agricultural use; in contrast, large tracts in the mountain ranges are sparsely settled and remote.

The climate is mild throughout the area; winters are rainy and cool, summers are dry and warm. The prevailing winds are westerly to north-westerly from the Pacific Ocean, cooling the coastal areas in summer and warming them in winter. The mountain ranges, which parallel the coast, are barriers to the prevailing winds, so that temperatures in interior valleys during the summer are high. The mountains facing the ocean are covered with thick brush and locally with timber, whereas the inland valleys and hills are grass-covered or nearly barren. Water is scarce in much of the area, and many of the streams are intermittent.

A close network of primary and secondary roads crisscrosses the valleys, which are linked from north to south by State Highway 1 along the coast, U. S. Highway 101 through the Santa Clara, Salinas, San Luis, Santa Maria, and Santa Ynez Valleys, and State Highway 33 along the western edge of the San Joaquin Valley. Good transverse roads are widely spaced, however, and many of the mountainous areas, particularly in the Santa Lucia, Diablo, and San Rafael Ranges, lack roads entirely or are served only by poor dirt roads that are impassable in wet weather. The Southern Pacific Railroad from San Francisco follows the Santa Clara Valley south to Gilroy, and crosses the south end of the Santa Cruz Mountains to Salinas. From Salinas it follows the Salinas River to Santa Margarita, crosses the Santa Lucia Range to San Luis Obispo, and parallels the coast in the southern part of San Luis Obispo County and in Santa Barbara County.

Field Work and Acknowledgments. This report is based in part on the strategic minerals investigations of chromite deposits in the Pacific Coast States by the U. S. Geological Survey between July 1938 and May 1945, and partly on unpublished data collected by members of the U. S. Bureau of Mines and the U. S. Geological Survey during World War I. The strategic minerals investigations included detailed mapping of the more productive deposits in San Luis Obispo and Santa Barbara Counties and in the Del Puerto area of Stanislaus County. Many of the deposits were visited several times as development work at the mines progressed.

The deposits in the other counties of the southern Coast Ranges are small and, with few exceptions, have been inoperative since World War I, so that no attempt was made to study them systematically in detail.

Data collected during the strategic minerals investigations for San Luis Obispo County and the Del Puerto area have been published, in part, in two U. S. Geological Survey reports.¹ The geology of the deposits described in these reports was studied by A. E. Bradbury, A. Brobecker, F. W. Cater, A. Drescher, A. B. Griggs, H. E. Hawkes, Jr., J. S. Livermore, R. H. Merriam, G. A. Rynearson, C. T. Smith, F. G. Wells, and D. P. Wheeler, Jr. Much of this work was done under the immediate supervision of F. G. Wells. Additional unpublished information gathered by these men has been freely used without reference.

Most of the information on deposits worked during World War I is derived from unpublished reports by E. L. Young, of the U. S. Bureau of Mines, and by N. L. Taliaferro, for the Committee on Geology and Mineral Resources, California State Council of Defense; the field work for these reports was done in 1917 and 1918.

Other sources of information, both published and unpublished, have been used in the preparation of this report. References to these data are included at appropriate places.

This report was prepared by G. W. Walker, who was ably assisted by W. P. Irwin in the compilation of maps and tables. The section on San Luis Obispo, Monterey, and Santa Barbara Counties is a revised version of an unpublished report that was originally prepared by A. B. Griggs in 1944.

During the strategic minerals investigations the personnel of the Geological Survey received many helpful suggestions and kindnesses from individuals and from organizations. Mine operators and owners and members of the U. S. Bureau of Mines and of the California State Division of Mines made available much detailed information, which is gratefully acknowledged.

GENERAL GEOLOGY

The geology of the southern Coast Ranges of California has been mapped only in part, but sufficient maps and reports, both published and unpublished, are available to establish a reasonably accurate record of past geologic events and also to establish an adequate background for a discussion of the geologic environment of the chromite deposits. The southern Coast Ranges, described geologically in some detail by Taliaferro² and Reed,³ can be divided into three major northwest-trending blocks or belts; in a broad sense, two of these blocks are geologically similar and consist dominantly of rocks of the Franciscan formation, associated ultramafic intrusives, and scattered and discontinuous patches of Cretaceous and Tertiary sedimentary rocks. The third block, which is between the other two, is composed largely of pre-Franciscan crystalline rocks and Cretaceous and Tertiary sedimentary rocks. South of the Coast

¹ Smith, C. T., and Griggs, A. B., Chromite deposits near San Luis Obispo, San Luis Obispo County, California: U. S. Geol. Survey Bull. 945-B, pp. 23-44, 1944.

Hawkes, H. E., Jr., Wells, F. G., and Wheeler, D. P., Jr., Chromite and quicksilver deposits of the Del Puerto area, Stanislaus County, California: U. S. Geol. Survey Bull. 936-D, pp. 79-110, 1942.

² Taliaferro, N. L., Geologic history and structure of the central Coast Ranges of California: California Div. Mines Bull. 118, pp. 119-163, 1941.

³ Reed, R. D., Geology of California, pp. 9-13, 27-59, 64, 74, 77-85, Am. Assoc. Petroleum Geologists, 1933.

Ranges, in Santa Barbara County, the lithology and structures are characteristic of the Transverse Ranges of California. Ultramafic rocks, in which all the primary chromite deposits are found, are exposed both in the Coast Ranges and in the Transverse Ranges, but all the deposits with known production are located in the Coast Ranges.

The old crystalline rocks, or basement complex, consist of quartzite, mica schist, amphibole schist, and marble of the Sur series, and the intrusive Santa Lucia quartz diorite. These rocks crop out over large areas in Monterey, San Luis Obispo, San Benito, and Santa Cruz Counties, and some smaller patches are exposed in the adjoining counties. The age of this complex of metamorphic rocks and intrusive quartz diorite is unknown, although Taliaferro⁴ suggests that it may be early Paleozoic or pre-Cambrian, or both. The next oldest rocks belong to the Franciscan formation of Jurassic (?) age, which consists chiefly of graywacke, shale, and altered mafic volcanics, but also contains minor amounts of chert, limestone, glaucophane schist, and actinolite schist. These rocks have been folded, intricately intruded by ultramafic and mafic rocks, and faulted. Although many areas in the southern Coast Ranges contain rocks of the Franciscan formation, these rocks are mainly limited to the Diablo Range, the San Francisco Peninsula, and the Santa Lucia Range. One area in the Nipomo quadrangle, San Luis Obispo County, contains rocks that are lithologically similar to the rocks of the Franciscan formation but contain a faunal assemblage characteristic of the Knoxville formation, which is presumably of Tithonian (late Jurassic) age.⁵ Other areas in which small patches of the Knoxville formation have been mapped are located in western Santa Barbara County, San Luis Obispo County, and elsewhere in the southern Coast Ranges.

As described by Fairbanks,⁶ Taliaferro,⁷ and others, the ultramafic rocks are intrusive into the Franciscan and Knoxville formations, but the ultramafic rocks apparently do not intrude (except for younger, plastic intrusions of highly sheared serpentine) the Cretaceous and Tertiary sedimentary rocks. As all chromite, other than detrital chromite, occurs in varieties of ultramafic rocks, or in their alteration product, serpentine, the search for chromite ore can be restricted to these rocks. The ultramafic rocks, therefore, are described in more detail in the following pages.

Younger sedimentary rocks, which range in age from early Cretaceous to Recent, are present throughout many parts of the area, but are mainly concentrated in and adjacent to the Salinas Valley and in the Santa Maria drainage area. They include a wide variety of sedimentary rocks, though predominantly they are sandstone and shale. Many of these younger rocks locally contain both intrusive and extrusive volcanics, of compositions ranging from rhyolitic to basaltic.

Structurally, the southern Coast Ranges are characterized by close folds and high-angle faults, both with northwesterly trends. The San Andreas fault zone—a great northwest-trending zone of dislocation that traverses the entire area—and a parallel zone of complex structures and dislocation commonly called the Nacimiento fault zone, cut the area

⁴ Taliaferro, N. L., *op. cit.*, pp. 121, 123.

⁵ Taliaferro, N. L., *op. cit.*, pp. 125-126.

⁶ Fairbanks, H. W., U. S. Geol. Survey Geol. Atlas, San Luis folio (no. 101), p. 6, 1904.

⁷ Taliaferro, N. L., *op. cit.*, p. 127.

into three large blocks. The central block, bounded on the east by the San Andreas fault zone and on the west by the Nacimiento fault zone, consists of pre-Franciscan crystalline rocks and Cretaceous and Tertiary sedimentary rocks. It contains virtually no rocks of the Franciscan formation or ultramafic intrusives. The eastern block, bounded on the west by the San Andreas fault zone and on the east by the overlapping Tertiary and Cretaceous rocks characteristic of the Great Valley of California, consists largely of rocks of the Franciscan formation, associated ultramafic intrusives, and scattered and discontinuous patches of post-Jurassic rocks; it contains none of the crystalline rocks characteristic of the central block. The western block, bounded on the east by the Nacimiento fault zone, consists, like the eastern block, dominantly of Franciscan rocks. The western and central blocks—and to a limited extent the eastern block—are subdivided into narrower strips by numerous, more or less parallel, shorter faults, most of which trend N. 30° - 40° W. In the western and eastern blocks, sheetlike masses of ultramafic rocks commonly occur in these zones of dislocation. As only old crystalline rocks and younger sedimentary rocks crop out in the central block, the folding in these rocks need not be considered here. On the other hand, folds in the Franciscan formation exposed in the other two blocks are intimately related to the distribution of some ultramafic masses and are, therefore, important in the distribution of chromite. Some ultramafic bodies have been intruded along the axial parts of anticlinal folds, as for example those east of Parkfield (Monterey County), south of New Idria (San Benito County), and in the Del Puerto area (Santa Clara and Stanislaus Counties).

Ultramafic Rocks

Numerous and widely distributed intrusive bodies of ultramafic rock are exposed in the southern Coast Ranges of California. Most of these rocks commonly have been called serpentine, because they are almost completely altered to minerals of the serpentine group; in some ultramafic masses, however, relict textures and minerals are sufficiently well preserved that a distinction can be made among the varieties of ultramafic rock exposed. Other ultramafic bodies are so thoroughly altered or sheared, or both, that it is not possible to distinguish the original characteristics of the parent rock. In outcrops where the primary textures and minerals are evident it has been possible to identify peridotite, saxonite, dunite, lherzolite, and pyroxenite. All of these ultramafic rocks, whether altered or unaltered, sheared or unsheared, invariably contain chromite as an accessory mineral; but in areas where the variety of ultramafic rock is known, it has been found, with but few exceptions, that the chromite deposits of noteworthy size are restricted to dunite masses. In this report an ultramafic rock is designated by its varietal name where the parent rock has been recognized; otherwise the rock is called serpentine.

Lithology. Peridotite is a crystalline ultramafic rock consisting of olivine and a pyroxene, with little or no feldspar. Pyroxenite differs from peridotite in lacking olivine; it contains about 95 percent pyroxene. Varieties of peridotite include saxonite, dunite, and lherzolite. In the variety called saxonite, the pyroxene consists principally of enstatite. The variety containing 95 percent or more of olivine is called dunite.

Lherzolite contains in addition to olivine, both orthorhombic and monoclinic pyroxenes.

Where fresh or only slightly altered, the varieties of ultramafic rock can be distinguished by the mineral content. In the southern Coast Ranges, however, most of these rocks have been thoroughly serpentinized; the primary minerals have altered to minerals of the serpentine group, and the alteration has obscured the primary minerals and textures. Furthermore, intense shearing in many ultramafic bodies has completely obliterated the original characteristics of the parent rock. Even where altered, however, some of these rocks can be distinguished in the field by the following criteria. Olivine alters to serphophite, chrysotile, or antigorite; all these minerals weather rapidly, leaving a smooth weathered surface. On the other hand, pyroxene, either fresh or altered, weathers less rapidly, so that weathered rocks containing pyroxene usually show rough surfaces that are studded with crystals of enstatite, or its pseudomorph bastite. Dunite, because of its high olivine content, weathers to smooth surfaces that are commonly the color of buckskin. Saxonite, which contains both olivine and enstatite, or their alteration products, weathers to a brownish-red, irregular surface, from which ragged crystals of the pyroxene stand out. On freshly broken surfaces, both serpentinized dunite and saxonite are dark grayish-green to black, but the saxonite nearly always can be distinguished by the cleavage faces on the enstatite or bastite.

Alteration. Many of the bodies of ultramafic rock are serpentinized; the olivine has altered to serphophite, fibrous chrysotile, antigorite, and magnetite, and the enstatite to bastite. The resulting rock, where fresh, is typically dark greenish gray to almost black; it weathers to lighter shades of gray or green and locally, where oxidized, to reddish brown. The serpentine is an incompetent rock, readily sheared and broken into fragments that have lustrous dark-green slickensided surfaces; highly sheared serpentine is called "slickentite." Magnesite is commonly found in serpentinized ultramafic rocks, particularly in zones of shearing and brecciation. Also along zones of shearing, hydrothermal solutions have locally altered the serpentine to silica-carbonate rock, which consists of silica in the form of quartz, chalcedony, or opal, together with magnesium and calcium carbonates.

Distribution and Structure. Ultramafic rocks, or their altered equivalents, occur as irregular, elongate masses and, locally, as elliptical bodies in most areas in the Coast Ranges where the Franciscan formation is exposed. Data on the distribution, size, and shape of these bodies, as they are shown on plates 1-5, have been obtained from many published and unpublished sources. The more important sources are from Fairbanks,⁸ Fiedler,⁹ Reiche,¹⁰ Taliaferro,¹¹ Trask,¹² Huey,¹³ Eckel et al,¹⁴ Waring,¹⁵

⁸ Fairbanks, H. W., U. S. Geol. Survey Geol. Atlas, San Luis folio (no. 101), 14 pp., 1904.

⁹ Fiedler, W. M., Geology of the Jamesburg quadrangle, Monterey County, California: California Jour. Mines and Geology, vol. 40, no. 2, pp. 177-250, 1944.

¹⁰ Reiche, Parry, Geology of the Lucia quadrangle, California: Univ. California Dept. Geol. Sci., Bull., vol. 24, pp. 115-168, 1937.

¹¹ Taliaferro, N. L., Geology of the Hollister quadrangle, California: California Div. Mines Bull. 143, in press; geologic map published, 1949. Unpublished maps of the Cape San Martin, Bryson, San Simeon, Adelaida, and Nipomo quadrangles; some of these are reconnaissance only.

¹² Trask, P. D., Geology of the Point Sur quadrangle, California: Univ. California Dept. Geol. Sci., Bull., vol. 16, pp. 119-186, 1926.

Dibblee,¹⁶ Lawson,¹⁷ Crittenden,¹⁸ Branner et al.,¹⁹ and Bailey.²⁰ The position and shape of some masses were taken from the geologic map of California.²¹ Most of the bodies of ultramafic rock are found in the two extensive blocks of Franciscan rocks, which are described in the section on general geology. A third and much less extensive belt of Franciscan rocks is exposed in the San Rafael Mountains of Santa Barbara County, but, though ultramafic masses occur in great number in this belt, only a few have been mapped. Other discrete masses of serpentine or peridotite crop out in other areas in the Coast Ranges, but most of them are small and, as far as is known, they contain no economic chromite deposits. Many of the masses, both large and small, occur in zones of intense shearing and crushing.

The bodies of ultramafic rock range from small patches and slivers only a few square feet in area to bodies as much as $12\frac{1}{2}$ miles long and 3 miles wide. No definite correlation has been made between the size of a chromite deposit and the size of the enclosing ultramafic mass; in San Luis Obispo County, however, the largest chromite deposits have been found in the largest ultramafic masses.

Most of the ultramafic rocks are in long, attenuated sill-like masses that trend northwest, parallel to the other major structural features. These masses commonly occur in fault zones or along contacts between the Franciscan formation and other rocks. Locally, however, some masses cut across the bedding or have crosscutting apophyses, and some appear to be plugs. A number of small serpentinized lherzolite plugs cut the Sur series in northern Monterey County.²² These apparently are barren or contain insignificant quantities of chromite. One large plug that crops out on Burro Mountain in southern Monterey County has been mapped by G. L. Bell.²³ The plug is nearly $1\frac{1}{2}$ miles in diameter and consists of a central core of relatively unaltered harzburgite—essentially the same as saxonite—with a thick surrounding mantle of serpentine. Larger elliptical pluglike bodies occur in anticlinal folds in the Franciscan belt east of the San Andreas fault zone. All these bodies of ultramafic rocks were apparently emplaced both by intrusions of magma or crystal mush into pre-Mesozoic and Mesozoic rocks and by the squeezing upward of highly sheared serpentinized ultramafics into both late Mesozoic and Tertiary rocks.

¹³ Huey, A. S., *Geology of the Tesla quadrangle, California*: California Div. Mines Bull. 140, pp. 1-75, 1948.

¹⁴ Eckel, E. B., Yates, R. G., and Granger, A. E., *Quicksilver deposits in San Luis Obispo County and southwestern Monterey County, California*: U. S. Geol. Survey Bull. 922-R, pp. 515-580, 1941.

¹⁵ Waring, C. A., *Petroleum industry of California*: California State Min. Bur., map folio accompanying Bull. 69, pls. 2-5, 1915.

¹⁶ Dibblee, T. W., Jr., *Geology of southwestern Santa Barbara County, California*: California Div. Mines Bull. 150, pp. 1-95, 1950.

¹⁷ Lawson, A. C., *U. S. Geol. Survey Geol. Atlas, San Francisco folio (no. 193)*, 24 pp., 1914.

¹⁸ Crittenden, M. D., Jr., *Geology of the San Jose-Mt. Hamilton area, California*: California Div. Mines Bull. 157, 74 pp., 1951.

¹⁹ Branner, J. C., Newsom, J. F., and Arnold, Ralph, *U. S. Geol. Survey Geol. Atlas, Santa Cruz folio (no. 163)*, 1909.

²⁰ Bailey, E. H., *Quicksilver deposits of the Parkfield district, California*: U. S. Geol. Survey Bull. 936-F, pp. 143-169, 1942.

²¹ Jenkins, O. P., *Geologic map of California*, six sheets, scale 1:500,000, California Div. Mines, 1938.

²² Fiedler, W. M., *op. cit.*, p. 192, fig. 30.

²³ Bell, G. L., *A geologic section of the Santa Lucia Mountains, Coast Range, California*: Univ. California, unpublished thesis (M.A.), (1940).

THE CHROMITE ORE

Only a brief discussion of the chromite ore of the southern Coast Range deposits will be presented here, because detailed descriptions of most of the more important occurrences of chromite ore have been given in published reports by Allen,²⁴ Smith and Griggs,²⁵ and Hawkes et al.²⁶ Some chemical analyses of ore samples and concentrates are presented in table 1; the data for this table were obtained from published analyses in the above-mentioned reports by Smith and Griggs and Hawkes et al. An analyses of chromite from Cedar Mountain, Alameda County, was published in a report by Kramm,²⁷ but this analysis is not given in table 1.

The primary chromite ore is principally of two intergrading types: chromite grains dispersed in the ultramafic host rock, and dense aggregates of chromite crystals. The former is called disseminated ore and the latter massive ore. Many deposits show a wide range in the concentration of chromite grains, from low-grade, highly disseminated ore to minable bodies of high-grade, massive chromite; some deposits, however, consist of massive chromite that occurs in barren dunite with no gradational zone or with a very narrow one, whereas other deposits consist only of disseminated ores that grade outward into leaner or barren dunite. Commonly other chromium-bearing minerals are found in small quantities associated with the chromite, but these are of no commercial value. They

²⁴ Allen, J. E., Geological investigations of the chromite deposits of California: California Jour. Mines and Geology, vol. 37, pp. 101-167, 1941.

²⁵ Smith, C. T., and Griggs, A. B., op. cit., pp. 29-30.

²⁶ Hawkes, H. E., Jr., Wells, F. G., and Wheeler, D. P., Jr., op. cit., pp. 91-95.

²⁷ Kramm, H. E., Serpentine of the central coast ranges of California: Am. Ph. Soc., Proc., vol. 49, pp. 315-349, 1910.

Table 1. Analyses of chromite ore and concentrates from Stanislaus and San Luis Obispo Counties (in percent) (R. E. Stevens, analyst).

Property	Crude ore		Concentrate			
	Chromite	Cr ₂ O	Cr ₂ O ₃	Cr	Fe	Cr:Fe
Stanislaus County*						
1 Adobe Canyon.....	68	40.85	60.00	41.08	13.00	3.16
2 Black Bart.....	71	30.50	42.70	29.21	11.62	2.52
3 E. Black Bart.....	35	14.50	41.03	28.10	13.51	2.08
4 No. 5 mine.....	53	30.70	57.62	39.43	16.36	2.41
San Luis Obispo County**						
1 Pick and Shovel mine.....	88	48.10	54.85	37.54	11.75	3.19
2 Pick and Shovel mine.....	74	38.90	52.87	36.19	12.56	2.88
3 Pick and Shovel mine.....	47	25.40	54.68	37.42	13.49	2.77
4 Sweetwater mine.....	84	42.80	50.77	34.73	13.52	2.57
5 Sweetwater mine.....	29	15.50	52.58	35.98	14.30	2.52
6 Sweetwater mine.....	86	45.40	52.59	35.99	13.12	2.74
7 Eucalyptus No. 1 claim.....	70	38.50	54.65	37.40	13.76	2.72
8 Castro mine.....	66	30.80	47.02	32.18	13.28	2.42
9 Seeley property.....	14	7.10	50.30	34.42	15.47	2.23
10 Seeley claims.....	13	7.60	56.47	38.65	14.41	2.68
11 Seeley claims.....	23	12.60	54.65	37.40	13.74	2.72
12 Trinidad mine.....	18	8.30	45.78	31.31	14.39	2.18
13 Norcross mine.....	37	19.10	51.45	35.21	13.81	2.55

* Data originally published in Hawkes, H. E., Jr., Wells, F. G., and Wheeler, D. P., Jr., Chromite and quicksilver deposits of the Del Puerto area, Stanislaus County, California: U. S. Geol. Survey Bull. 936-D, p. 91, 1942.

** Data originally published in Smith, C. T., and Griggs, A. B., Chromite deposits near San Luis Obispo, San Luis Obispo County, California: U. S. Geol. Survey Bull. 945-B, p. 31, 1944.

*Table 2. Annual shipments of chromite ore and concentrates from the southern Coast Ranges of California, by counties, 1900-1945 (in long tons).**

Year	Alameda	San Benito	San Luis Obispo	Santa Barbara	Santa Clara	Stanislaus	Total
Pre-1900.....	984	--	21,478	--	179	--	22,641
1900-07.....	--	--	--	--	--	--	--
1908-11.....	--	--	--	--	--	--	--
1912.....	44	--	--	--	--	--	44
1913-15.....	--	--	--	--	--	--	--
1916.....	350	--	1,945	--	40	889	3,224
1917.....	271	--	455	--	49	745	1,520
1918.....	167	18	9,935	446	236	2,684	13,486
1919.....	--	--	1,239	--	--	--	1,239
1920.....	--	--	99	--	12	--	111
1921.....	--	--	--	--	--	--	--
1922.....	--	--	46	--	--	--	46
1923.....	--	--	24	--	--	--	24
1924.....	--	--	--	--	--	--	--
1925.....	--	--	61	--	--	--	61
1926.....	--	--	47	--	--	--	47
1927.....	--	--	--	--	--	--	--
1928.....	--	--	40	--	--	--	40
1929.....	--	--	86	--	--	--	86
1930.....	--	--	54	--	--	--	54
1931-32.....	--	--	--	--	--	--	--
1933.....	--	--	100	--	--	--	100
1934.....	--	--	49	99	--	--	148
1935.....	--	--	--	61	--	--	61
1936.....	--	--	5	84	--	--	89
1937.....	--	--	36	22	--	--	58
1938-39.....	--	--	--	--	--	--	--
1940.....	--	--	--	--	--	140	140
1941.....	--	--	--	16	--	38	54
1942.....	--	39	5,070	36	--	--	5,145
1943.....	--	--	11,910	--	--	--	11,910
1944.....	--	118	10,672	--	--	--	10,790
1945.....	--	18	241	--	--	--	259
Totals.....	1,816	193	62,692	764	516	4,496	70,477

* Production figures from published and unpublished records of U. S. Geological Survey, U. S. Bureau of Mines, and Metals Reserve Co.

include the emerald-green chrome garnet, uvarovite, and the lavender to pink micaceous chlorite, kammererite. Secondary, sedimentary concentrations of chromite in beach sands and stream gravels, and as residual weathered lumps of chromite on hillsides, also have been developed to a limited extent in the southern Coast Ranges.

The chromite ore bodies are all in close association with masses of dunite that lie within the larger masses of peridotite. These ore bodies occur in a variety of shapes and sizes, and commonly they are found in zones of shearing. Most of the disseminated ore occurs in tabular bodies, some of which show layers of nearly barren dunite and linear streaks of chromite grains. In some disseminated ore the chromite grains are concentrated into small clots and pods, which may be either scattered or concentrated in the ultramafic host rock. Massive ore occurs in lenses or pods, in stringers or seams, and in irregular-shaped bodies. The chromite bodies may be a few inches to several tens of feet thick and as much as 200 feet long.

Production and Reserves

More than 130 chromite mines and prospects, of which 75 or more are located in San Luis Obispo County, have been worked intermittently

since the earliest mining of chromite in the southern Coast Ranges, in the 1870's. According to Whitney,²⁸ the occurrence of chromite near New Idria, San Benito County, was known in 1855, but there is no record of production until nearly 20 years later. Through 1945, the recorded total lump ore and concentrates shipped from properties in the southern Coast Ranges was almost 71,000 long tons, of which more than 62,000 long tons was produced in San Luis Obispo County (table 2). The lump ore varied widely in grade but probably averaged about 45 percent Cr_2O_3 with a chromium-iron ratio slightly higher than 2.5 to 1. The concentrates shipped averaged about 44 percent Cr_2O_3 and had a chromium-iron ratio of about 2.8 to 1. Almost-pure chromite that was carefully concentrated from samples of disseminated ore from San Luis Obispo County had Cr_2O_3 contents ranging from 46 to 57 percent, and had chromium-iron ratios between 2.73 to 1 and 2.18 to 1.²⁹

Most of the known deposits containing shipping-grade ore were exhausted by the end of World War I, and little lump ore has been mined since that time. Although further prospecting near the larger mined-out high-grade deposits might locate similar deposits, it is believed that future operations will be limited mainly to milling. It is not possible to make a valid estimate of the total reserves of disseminated ore in the southern Coast Ranges; in 1943, however, it was estimated that the known deposits in San Luis Obispo County contained 35,000 tons of inferred ore averaging between 5 and 10 percent Cr_2O_3 . Since 1943, some of these reserves have been depleted, although at the Castro mine a new ore body, estimated to contain considerable ore, is reported by Durand A. Hall.³⁰ Reserves in Stanislaus County are estimated to be about 1,800 tons of ore in sight averaging 10 to 15 percent Cr_2O_3 . Production of chromite from the other counties in the southern Coast Ranges practically ceased after World War I, and even before that time production was small; so present reserves are probably small.

Guides to Prospecting

Few general guides to prospecting for chromite can be given beyond the well-known one that notable concentrations of primary chromite are confined to bodies of unaltered or altered peridotite, and occurs specifically in association with dunite. Studies that have been made of peridotite bodies have failed to discover any rule for the distribution and localization of chromite deposits within them. Generally, the chromite ore bodies are scattered through the peridotite with little apparent system, although commonly the zones in which the ore bodies occur tend to lie parallel to the trend of the ultramafic masses. Further study may yield some guides to ore localization, and therefore a chromite deposit should always be considered in relation to the structure of its host mass of peridotite. Pods of massive ore are most commonly found in zones of intense shearing and serpentinization in the peridotite masses. The margins of ultramafic bodies commonly tend to be sheared and more highly serpentinized because the margins mark a structural discontinuity and a zone of weakness. Marginal areas of ultramafic bodies probably were also deformed and crushed during emplacement. Other zones of weakness are found within

²⁸ Whitney, J. D., Geological survey of California; Geology, vol. 1, Report of progress and synopsis of field work from 1860 to 1864, pp. 58-59, 1865.

²⁹ Smith, C. T., and Griggs, A. B., op. cit., p. 32.

³⁰ Durand A. Hall (president, Castro Chrome Associates), oral communication.

the peridotite masses, and these zones commonly trend northwest, parallel to the major structures of the region. There is no apparent reason why ore should occur preferentially in these zones, but the fact is that the largest producing deposits in the southern Coast Ranges, including those near San Luis Obispo, are in these zones of weakness. Chromite commonly has either planar or linear structure; this is true of both the massive ore and the disseminated ore. Therefore, extensions of massive ore are more apt to occur along the linear axis of known pods, and likewise the extensions of disseminated ore most commonly occur along the major axis of a body of disseminated ore.

DESCRIPTION OF THE DEPOSITS

The better-known chromite deposits of the southern Coast Ranges are described in the following pages. For convenience, the deposits are arranged alphabetically by counties, which are likewise arranged alphabetically. In some places, however, it is necessary to modify this alphabetical arrangement to conform to the natural grouping of the deposits within the ultramafic bodies. Each deposit is described under the most recent name known for the property. Correlation of the old and new names for a few of the smaller prospects and mines that have been worked intermittently since the 1880's or 1890's has not always been possible, however; so the same deposit may be treated under two or more names. In table 3 the deposits are listed alphabetically, by counties, with a few of the alternate names cross-referenced. Most of the smaller or less well known deposits are also listed in table 3, although they are not described individually.

Alameda County

Most of the chromite deposits of Alameda County are in the southeastern corner of the county (see pl. 1), in the Tesla quadrangle. The deposits occur mainly in the serpentized ultramafic rocks that crop out along Cedar Mountain Ridge. In this area some of the ultramafic bodies are nearly equidimensional, such as the serpentine mass near the summit of Cedar Mountain, whereas others are long, attenuated and irregular-shaped masses that are aligned in a west-northwest direction, parallel with the prevailing structures in the adjoining Franciscan formation. Chromite is found as irregular lenses and stringers and locally as disseminated grains in the sheared serpentine.³¹

Chromite was first mined in Alameda County shortly after 1880; since that time a number of properties have been operated intermittently. Records of production are conflicting; production figures range from a total of 1,816 long tons, which is considered a reasonable minimum figure, to a maximum of nearly 7,000 tons. Ireland³² reported that prior to 1888 about 5,000 (short?) tons of ore had been shipped from the Douglas mine and the Cedar Mountain claim, and this, plus the 1,500 to 2,000 tons mined between 1890 and the end of World War I, would make the total production through 1919 nearly 7,000 tons. Published State and Federal production records do not substantiate this maximum figure, but they do indicate that through 1885 about 400 long tons had been taken from the

³¹ Huey, A. S., *Geology of the Tesla quadrangle, California*: California Div. Mines Bull. 140, p. 59, 1948.

³² Ireland, William, Jr.; *California State Min. Bur. Rept. 8*, p. 34, 1888.

Cedar Mountain claim. No ore has been shipped from Alameda County since 1919.

*Clark Claim (2).*³³ The Clark claim is located in the S $\frac{1}{2}$ sec. 26, T. 4 S., R. 3 E., about 15 miles southeast of Livermore, the nearest shipping point. During World War I the property was owned by Vernon Clark, of Livermore; in 1916, 45 long tons of ore was produced by the Noble Electric Steel Co. under a lease. The property was worked by an inclined shaft; however, in 1916 the shaft hit water and subsequently the mine was abandoned.

Douglas Mine (4). A series of tunnels and open cuts expose irregular veinlets and masses of chromite near the summit of Cedar Mountain in the SW $\frac{1}{4}$ sec. 26, T. 4 S., R. 3 E. The mine is located near the southern margin of a rudely equidimensional serpentine mass that is more than a mile in diameter. The property was known as the Douglas mine in 1888, and production prior to this date is reported as about 3,000 tons of chromite ore. This production figure seems too large, considering that the Alameda chromite deposits were not discovered until 1882 or later. From data available in 1951 it seems possible that the Douglas mine was the same property that was later called the Cedar Mountain claim, the Mendenhall mine, and, most recently, the Newman mine.

Newman Mine (Cedar Mountain Claim or Mendenhall Mine) (3). The Newman mine, also known as the Cedar Mountain claim and the Mendenhall mine, is located in the SE $\frac{1}{4}$ sec. 26, T. 4 S., R. 3 E., near the summit of Cedar Mountain, about 15 miles southeast of Livermore. Chromite was first discovered on this property about 1882, and nearly 400 long tons of ore averaging between 47 and 51 percent Cr₂O₃ had been mined through 1885. Workings consisted of numerous open cuts and adits along the border of a sheared serpentine mass. The property has been owned and operated during its productive history by members of the Mendenhall family and by S. V. Newman. In 1916, the Noble Electric Steel Co. mined and shipped several hundred tons of ore under a lease. The property was leased to J. W. Clark and D. McDonald in October 1917, and they operated the mine during 1918 and 1919. Since 1919 the mine has been inactive. Total production from the property is probably between 1,000 and 1,500 long tons of chromite, though shipment of as much as 3,000 long tons of ore has been reported.

The chromite occurs as irregular lenses and stringers and locally as disseminated grains in sheared serpentine. The ore is commonly soft and friable and is mostly of low grade. Some higher-grade and more compact ore, however, is associated with the friable material.

Contra Costa, San Francisco, and San Mateo Counties

Chromite is reported to occur in the ultramafic bodies that are exposed in Contra Costa,³⁴ San Francisco,³⁵ and San Mateo³⁶ Counties, but there is no record of any production of chromite from these counties. In Contra Costa County there are two main areas in which pre-Upper Cretaceous rocks are exposed; one is in the western part of the county and the other

³³ Numbers in parentheses refer to plate 1 and table 3.

³⁴ Laizure, C. McK., Contra Costa County: California State Min. Bur. Rept. 23, p. 12, 1927.

³⁵ Hanks, H. G.; California State Min. Bur. Rept. 4, p. 137, 1884.

³⁶ Hamilton, Fletcher; California State Min. Bur. Rept. 17, p. 172, 1921.

is centrally located in the vicinity of Mount Diablo. In the pre-Cretaceous rocks near Mount Diablo an irregular-shaped, narrow, 4-mile-long body of ultramafic rock is exposed. Apparently some concentrations of chromite have been found within this body, because the Mt. Diablo Development Co. located claims prior to 1927 in T. 1 N., R. 1 W., and called the property the Mount Zion Chrome mine. A little development work was done on the claims, but there is no record of any ore shipments.

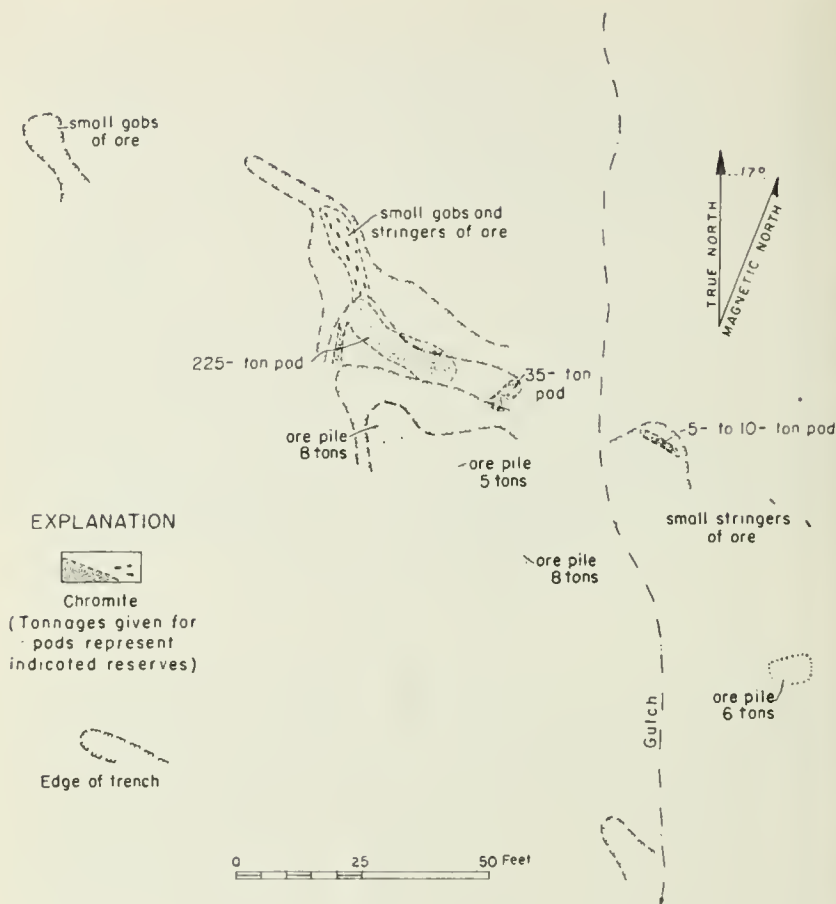
Rocks of the Franciscan formation, and associated ultramafic bodies, are brought to the surface along the northern end and eastern part of the San Francisco Peninsula by a series of great faults, of which the best known is the San Andreas fault. Only younger sedimentary rocks, associated volcanic rocks, and quartz diorite crop out to the west of this zone of faulting and, therefore, no chromite deposits will be found in the area west of this zone. In the area east of the zone ultramafic rocks occur as narrow, elongate bodies, which are highly sheared and serpentinized, and which commonly lie along faults. Near Crystal Springs Reservoirs, San Mateo County, low-grade chromite ore occurs in small bunches in the serpentinized ultramafic masses in and adjacent to the San Andreas fault zone. Chromite has also been found on the beach below the outlet from Lake Merced in San Francisco County, but these deposits are small and unsuitable for commercial exploitation.

Monterey County

The geology of much of Monterey County is little known. This is specially true of the high, rugged Santa Lucia Range west of the Nacimiento River, a region largely inaccessible by road, where pre-Cretaceous rocks are exposed. Several occurrences of chromite have been reported from the accessible edge of this region. Two of the deposits, the Daisy (Aldelabran) and the Evans Ranch, are sufficiently well known to be described here. A plug of fresh saxonite that forms Burro Mountain, in sec. 1, T. 24 S., R. 6 E., does not contain commercial concentrations of chromite, but it is not unreasonable to assume that other ultramafic bodies containing chromite deposits could be found. Ultramafic bodies crop out on Table Mountain in the southeast corner of the county and are reported to contain small quantities of chromite, but little is known about these occurrences. It is unlikely that chromite deposits will be found in the remainder of the county, as it is underlain, as far as known, by pre-Franciscan crystalline rocks and post-Franciscan sedimentary rocks. No production has been recorded from any of the chromite deposits in the county.

Daisy (Aldelabran) Deposit (12). The Daisy chromite deposit is in the SW $\frac{1}{4}$ sec. 29, T. 23 S., R. 6 E., on the northeast side of Los Burros Creek at an altitude of about 2,300 feet. The nearest shipping point is King City, 40 miles to the northeast by road and trail; 30 miles of this distance is paved road, 2 miles is dirt road, and 8 miles is trail.

The ore bodies are in a small sill-like mass of serpentine 100 to 300 feet wide and 500 to 600 feet long, striking N. 60° to 70° W. and dipping 60° to 80° NE. The ore occurs as a series of pods and stringers of high-grade chromite that roughly parallel the strike and dip of the serpentine body (fig. 2). The pods are restricted to a zone about 200 feet long, roughly parallel to the slope of the hill, with a vertical distance of about



By G. A. Ryneerson, 1942

FIGURE 2. Sketch map of the Daisy (Aldelabran) chromite deposit.

50 feet between the highest and lowest pods. The grade of the ore is estimated at between 45 and 50 percent Cr_2O_3 .

Evans Ranch Deposit (13). An appreciable amount of chromite float is exposed within an area 10 feet in diameter on the ranch of W. J. and J. C. Evans, in the NW $\frac{1}{4}$ sec. 26, T. 24 S., R. 6 E., on the northwest side of Devils Canyon. The serpentine directly under the float contains grains of disseminated chromite, and, therefore, it seems probable that the float is the residual remnant of a small ore body.

San Benito and Western Fresno Counties

The chromite deposits of San Benito and western Fresno Counties have been grouped in this report, because nearly all of the more productive mines and deposits are located in a single, large ultramafic mass that is exposed immediately south of the New Idria quicksilver mine on the

boundary between the two counties (pl. 3). Other chromite deposits in Fresno County are found mainly in the large ultramafic mass exposed in the Watts Valley quadrangle about 25 miles northeast of Fresno; these deposits of eastern Fresno County have been described in detail by Ryneerson.³⁷

Incomplete records of chromite mining in San Benito and western Fresno Counties indicate that as much as 700 long tons of chromite may have been shipped from this area via King City, Mendota, and Coalinga during the period from 1917 to 1945. The most productive years were during World War I and World War II; between 1942 and 1945 about 140 long tons of ore averaging 55 percent Cr_2O_3 was shipped to the Metals Reserve Co. stockpiles at Tracy (in San Joaquin County) and Fresno, and about 35 long tons was shipped elsewhere. The largest producers from this area have been the Aurora mine, the Hines deposits, the Jeanne mine, the Tirado Chrome mine, and the Valdez Bros. Chrome mine; these and other deposits are listed in table 3.

The chromite deposits occur in a serpentine mass that is $12\frac{1}{2}$ miles long and ranges from 3 to $4\frac{1}{2}$ miles in width. It consists largely of dark-green to brown, commonly strongly sheared serpentine that is bounded by the Franciscan formation of Jurassic(?) age and locally by the Panoche formation of Cretaceous age. According to Eckel and Myers³⁸ the chromite occurs as small lenses and pods in the highly sheared serpentine; most of these pods are cut by slickensided veinlets of the emerald-green chrome garnet, uvarovite. Much of the exploited chromite, however, was obtained not from the pods but from float boulders that had weathered from the surrounding serpentine and were found on the hillsides and in the gravels of adjoining creeks.

San Luis Obispo County

San Luis Obispo County has produced a total of more than 62,000 long tons of chromite ore, and thus ranks first among the chromite-producing counties of California. Prior to 1915 the total production of chromite was about 21,480 long tons, consisting largely of lump ore from high-grade pods and lenses. In the period 1916 to 1920, approximately 13,670 long tons of lump ore and concentrates were shipped. Only small quantities of ore were shipped between 1920 and 1942, but the increase in price during World War II renewed mining activity and the yearly production again increased. From 1942 to 1945 the county yielded nearly 27,000 long tons of ore, mostly as concentrates.

The chromite is invariably associated with masses of dunite that occur in the numerous serpentinized ultramafic bodies that are widely distributed in a northwest-trending belt of the Franciscan formation in the western part of the county. The ore deposits are of two types: massive lenses of granular chromite commonly averaging more than 50 percent Cr_2O_3 (see table 2), and somewhat lower-grade deposits consisting of small clots and disseminated grains of chromite in the serpentinized dunite.

Mining of chromite in the county began in the early 1870's, and since that time more than 75 mines and prospects have been intermittently

³⁷ Ryneerson, G. A., Chromite deposits of Tulare and eastern Fresno Counties, California: California Div. Mines Bull. 134, part 3, chap. 3, pp. 61-104, 1948.

³⁸ Eckel, E. B., and Myers, W. B., Quicksilver deposits of the New Idria district, San Benito and Fresno Counties, California: California Jour. Mines and Geology, vol. 42, no. 2, p. 89, 1946.

active. The larger properties were examined in 1940 and 1941 by the U. S. Geological Survey, and they are described in a report by Smith and Griggs.³⁹ Detailed results of sampling and assaying of chromite ore from the Sweetwater, Castro, Trinidad, New London, and Hilltop properties are presented in a report by the U. S. Bureau of Mines.⁴⁰

The chromite deposits of San Luis Obispo County (pl. 4) occur in four geographic areas: (1) northern San Luis Obispo County, which includes all the deposits as far south as Morro, except the deposits in the Cerro Alto-Cuesta Pass area; (2) Cerro Alto-Cuesta Pass area, which includes all the deposits in the large mass of serpentine from 4 to 12 miles north of San Luis Obispo; (3) San Luis Obispo-Arroyo Grande area, which includes all the deposits south and east of the Cerro Alto-Cuesta Pass area; and (4) San Luis Range area, which includes the deposits west and south of San Luis Obispo. The following descriptions of some of the larger deposits or groups of deposits are, therefore, given alphabetically by geographic areas. Many of the smaller deposits, though not described in detail, are listed, with references, in table 3.

Northern San Luis Obispo County

*Cienaga Mine (17).*⁴¹ The Cienaga mine is on the ranch of Pete Quintana, 1½ miles east of Morro and a quarter of a mile north of State Highway 1. The workings consist of several cuts and two short tunnels from which small pods of massive chromite, a ton or so in size, have been removed. The chromite pods lie in a sheared and silicified zone in serpentine that strikes N. 80° W. and dips steeply to the north. Chromite float has been found for a distance of 1500 feet along the outcrop of this zone. When Young⁴² visited the deposit in July 1918, he estimated that 10 tons had been mined.

Fitzhugh Ranch (Benton) Deposits. Franke⁴³ lists a chromite deposit on the ranch of William Fitzhugh and son, 12 miles east of Cambria. It is probably the same property that Young⁴⁴ describes as the Benton, where very small pods of chromite were scattered for 120 feet along a shear zone in serpentine. A few tons of ore was taken out of the surface workings, but very little ore was found in the 350 feet of tunnels dug beneath the open cuts.

Harris Claims. Young describes showings of chromite on two claims located by Walter R. Harris about a mile apart, 6 and 7 miles south of the Sands Ranch, in San Luis Obispo County, just south of the Monterey County line. He states that on one of the claims a band of disseminated chromite 30 feet long and 1½ feet wide was exposed in an open cut and on the other a stringer of nearly massive chromite 12 feet long and 2 to 12 inches wide was exposed in a trench.

³⁹ Smith, C. T., and Griggs, A. B., Chromite deposits near San Luis Obispo, San Luis Obispo County, California: U. S. Geol. Survey Bull. 945-B, pp. 23-44, 1944.

⁴⁰ Smith, M. C., and Ricker, S., Chromite deposits: Sweetwater, Castro, Trinidad, New London, and Hilltop mines, San Luis Obispo County, California: U. S. Bur. Mines Rept. Inv. 4783, pp. 1-7, 1951.

⁴¹ Numbers in parentheses refer to plate 4 and table 3.

⁴² Young, E. L., Unpublished reports for U. S. Bur. Mines (1918), in files of California Div. Mines.

⁴³ Franke, H. A., Mines and mineral resources of San Luis Obispo County, California: California Jour. Mines and Geology, vol. 31, no. 4, p. 412, 1935.

⁴⁴ Young, E. L., op. cit.

Jitney Mine (8). The Jitney mine is in sec. 32, T. 28 S., R. 11 E., on the ranch of T. H. Keys, of Morro, Calif. It is on the steep north slope of Toro Creek, 5 miles above its mouth, and 8 miles from Morro. Two showings of chromite opened by surface cuts yielded 40 tons of ore during the early days of mining, according to Young. One was reopened in 1918, and was found to contain small bunches and pods of massive chromite in an intensely sheared zone, about 10 feet wide, in serpentine. Magnesite is associated with the chromite in the sheared zone. Young reported that $8\frac{1}{2}$ long tons of ore had been produced during the first half of 1918, and estimated that the total production for the year would be 20 long tons.

Luchessa Ranch Deposit. Young reports that a pod of chromite was found on the north side of San Simeon Creek, about 2 miles from its mouth, on the ranch of A. Luchessa. The ore was mined out to a depth of 12 feet, and, in prospecting further, two tunnels and an open cut were dug, but very little chromite was found.

Mable G. Mine (9). The Mable G. mine is said to have been located 3 miles northwest of Morro on the hillside east of State Highway 1, on land that was owned by the Lewis Foundation Corp., of Atascadero. A small pod of massive chromite in serpentine was found by tracing float up the hillslope. When Young visited the property in July 1918, 3 tons had been mined and a small amount remained in the pod.

Middlemast Ranch Deposits (7). The Middlemast Ranch deposits, which have been mined out, consisted of three small lenses; two were near the center of sec. 25, T. 28 S., R. 10 E., and the other in the NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 30, T. 28 S., R. 11 E. Exposures of serpentine in this vicinity are very small, and the chances of finding large ore bodies are regarded as unfavorable.

Mountain View Deposit (16). The Mountain View deposit is in the SW $\frac{1}{4}$ sec. 23, T. 29 S., R. 11 E., near the county road on property belonging to E. Caccia, of Morro. A narrow, discontinuous seam of chromite in a zone of fractured serpentine was prospected by means of a tunnel. Only barren serpentine was found in a pit dug under a float occurrence 200 feet down the hill from the tunnel. Less than 100 pounds of chromite had been collected when Young visited the property in July 1918.

Ocean View Deposit. The Ocean View deposit is about $1\frac{3}{4}$ miles northeast of Morro and 1 mile north of the county road, on the ranch of Pete Quintana. Nodular and disseminated chromite was found in a sheared and silicified zone, 3 to 5 feet wide, in serpentine. Very little of the ore was of shipping grade and only $2\frac{1}{2}$ long tons, most of which was float, had been collected when Young visited the property in July 1918.

Peppard Ranch Deposit. Young reports that a small showing of chromite was found on the M. T. Peppard Ranch on the north fork of Santa Rosa Creek, 10 miles east of Cambria, in the same narrow and elongated body of serpentine as the Fitzhugh Ranch (Benton) deposits.

Pine Mountain Claims (Chisholm Mine and Old Timer Mine) (5). The Pine Mountain claims, in secs. 3 and 10, T. 26 S., R. 8 E., are described by Logan⁴⁵ and Young as being on the south slope of Pine Moun-

⁴⁵ Logan, C. A., Chromium, in Bradley, W. W., et al., Manganese and chromium in California: California Min. Bur. Bull. 76, pp. 175-176, 1918.

tain just above the contact between shale and serpentine. The chromite occurs in small, irregular bunches in sheared serpentine; the largest body observed was about 8 feet long and 2 feet wide, and graded from massive to disseminated ore. Up to July 1918, total shipment was 45 long tons, averaging 38 percent Cr_2O_3 . An additional 40 long tons was mined and ready to be shipped.

Porta Bros. Ranch Deposit. A small deposit of disseminated chromite was found on the Porta Bros. Ranch about three-fourths of a mile north of San Simeon Creek, 4 miles from the mouth of the creek. It was prospected in 1918, but the ore was too low in grade for direct shipping and too small in quantity to justify a mill, and Young did not believe that any ore would be shipped.

Rancho Santa Rita. Several small occurrences of chromite have been found within a northwest-trending serpentine area about 600 feet wide and a mile long, exposed on Rancho Santa Rita. The ranch is owned by F. Juhl, G. Juhl, and C. Juhl, of Templeton, and is 9 miles northeast of Cayucos on the Cayucos-Cambria road. Massive chromite occurs in pods of about 2 tons and smaller. Young reported that $3\frac{1}{2}$ long tons had been mined up to July 1918.

Rogers Ranch Deposit. Scattered pieces of chromite float were found on San Simeon Creek, on the ranch of G. E. Rogers and C. H. Rogers, of Cambria. This chromite is about 600 feet west of the Luchessa Ranch deposit in the same serpentine lens.

Rogers San Carpojarro Creek Deposits (2). Three showings of chromite were located by G. E. Rogers and C. H. Rogers on their ranch on San Carpojarro Creek, according to Young. Large, round boulders of chromite float, totaling about 1 ton, were scattered over the surface near the old cabin in the NW $\frac{1}{4}$ sec. 4, T. 25 S., R. 7 E. The other two occurrences are in sec. 5, T. 25 S., R. 7 E., within the same large body of serpentine. One was described as an outcrop of disseminated chromite about 30 feet in diameter, and the other as two small pods of massive chromite in a shear zone in serpentine, which could be traced by float for 800 feet. No development work had been done at these three localities when Young visited them in 1918.

San Carpojarro Creek Deposits (Arroyo La Cruz, Owl No. 1, and Owl No. 2) (4). The San Carpojarro Creek deposits are in sec. 12, T. 25 S., R. 7 E., on the divide between San Carpojarro Creek and Arroyo de la Cruz, at an altitude of 2,150 feet. A pod of chromite 5 feet wide that Logan had observed in place was mined out by the time Young visited the claims in 1918, but Young observed another showing of chromite 800 feet distant, with much scattered float between.

Zerfing Ranch (Old Creek) Deposit (6). A caved stope and drift on the Zerfing (now Old Creek) Ranch, in the SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, T. 28 S., R. 10 E., constituted the only visible remains of the deposit when examined by Griggs⁴⁶ in 1941. Logan, in 1918, described the deposit as a streak 8 inches to 2 feet wide, about 60 feet long, and striking N. 60° E., across the old Creek-Santa Anita road; he reported that 10 tons of ore averaging 46 percent Cr_2O_3 and 8 percent SiO_2 had been shipped.

⁴⁶ Smith, C. T., and Griggs, A. B., op. cit., p. 44.

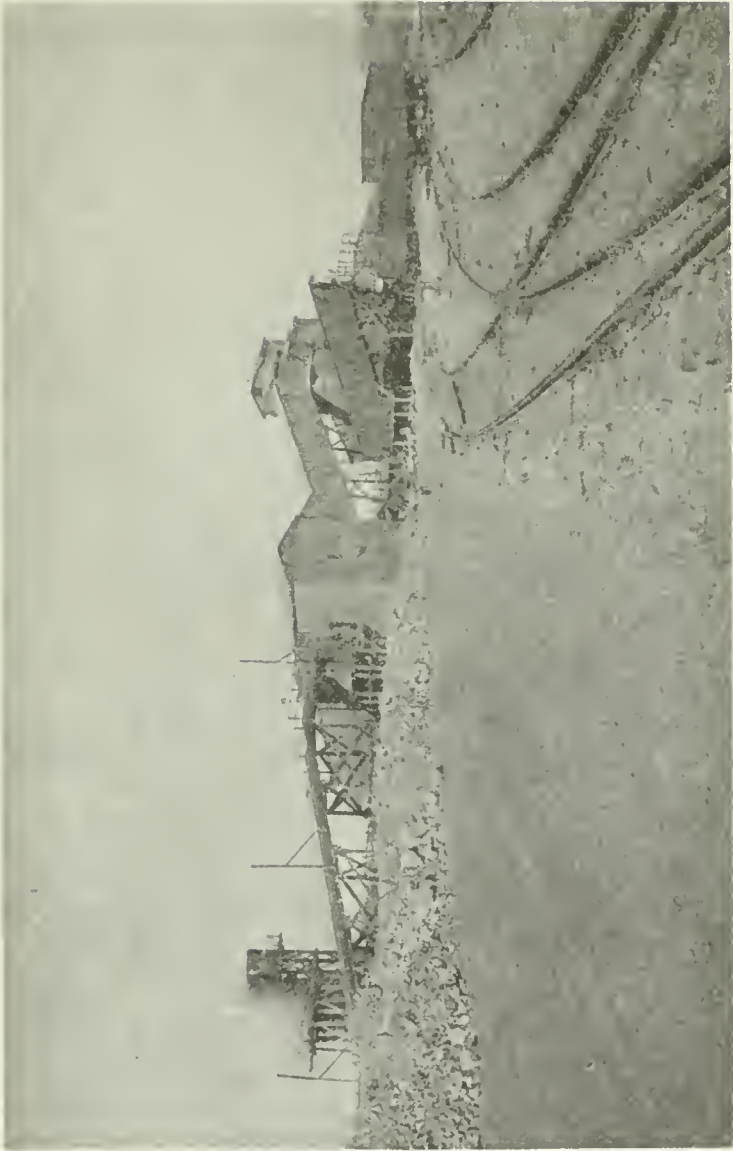


FIGURE 3. Castro mill at Goldtree Siding. Photo by W. W. Bradley, 1943.

Cerro Alto-Cuesta Pass Area

All the chromite deposits of the Cerro Alto-Cuesta Pass area occur in an irregular and elongate body of ultramafic rocks that crops out for nearly 12 miles along the summit of the Santa Lucia Range north and northwest of San Luis Obispo. The ultramafic body, which contains many of the largest known chromite deposits in the southern Coast Ranges, has been thoroughly broken by faulting and shearing. Generally, the shear zones trend northwest, parallel to the trend of the ultramafic mass, and commonly the chromite deposits are rudely aligned along the zones. Most of the known chromite ore near the surface has been exhausted, but in view of past production it is reasonable to assume that additional ore bodies can be found.

Castro Mine (19). The Castro mine is in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 29 S., R. 12 E., on the crest of a spur running southwest from the main ridge of the Santa Lucia Range, at an altitude of 1,600 feet. Castro Chrome Associates (Durand A. Hall, president) of San Francisco, the owners, operated the mine from May 1942 to November 1944. The ore, which averaged about 20 percent Cr₂O₃, was hauled 6 miles to their mill at Goldtree Siding (fig. 3). During the 2½ years of operation they produced 25,510 dry long tons of concentrate averaging 42 to 43 percent Cr₂O₃ and having a chromium-iron ratio of 2.6-2.8 to 1; they also shipped about 40 tons of lump ore during 1943. During World War I, 3,146 tons of concentrates was produced at the Castro mine and 78 tons was produced in 1933. Some chromite was produced between 1870 and 1890, but there are no production figures available for this period. Total production at the Castro mine up to November 1944, therefore, is in excess of 28,774 long tons.

The U. S. Geological Survey mapped the deposit in 1939 and on its recommendation the U. S. Bureau of Mines, in cooperation with the Geological Survey, explored the deposit in 1941. The results of this work are published in Geological Survey Bulletin 945-B⁴⁷ and Bureau of Mines Report of Investigations 4783.⁴⁸ At that time six separate ore bodies were explored; only three of these, however—the lower, upper, and northern ore bodies—were of any size (see Smith and Griggs, pl. 8). Since then, the Castro Chrome Associates, by mining and further exploration, have found extensions of the three largest ore bodies and have discovered five others. The relationship of these new ore bodies to the older ore bodies is shown on plate 6. A roll near the center of the lower ore body gave it a maximum thickness of 50 feet, and the upper and northern ore bodies were found to be more elongate than was first thought. The five new ore bodies were arbitrarily numbered 1, 2, 3, 4, and 5. No. 1 was a flat-lying tabular mass that thinned from a thickness of 15 feet at each end to 4 feet near the center. Both No. 2 and No. 4 were irregular, blocklike pods, having maximum thicknesses of 10 and 20 feet, respectively. No. 3 was an irregular, elongate, wedge-shaped mass that pinched and swelled along its length from a maximum of 30 feet to less than 15 feet. It pitched at a low angle toward the northwest. No. 5 was a thin, sheetlike mass that had a maximum thickness of only 4 feet.

⁴⁷ Smith, C. T., and Griggs, A. B., op. cit.

⁴⁸ Smith, M. C., and Ricker, S., op. cit.

In all the ore bodies the ratio of chromite to serpentine remained nearly uniform, averaging about 50 percent chromite. The only exception was the near-massive ore commonly found along the edges of the ore bodies. Rodingite (white) dikes cut the peripheries of the ore bodies in many places. The boundaries of the five new ore bodies are sharp.

By June 1944, all but a part of the upper ore body had been mined out. Approximate tonnages of ore in short wet tons taken out of each body are as follows: lower ore body, 39,000; northern ore body, 1,500; upper ore body, 6,000; No. 1, 4,000; No. 2, 500; No. 3, 10,000; No. 4, 2,000; No. 5, 1,000. In 11 holes located south of the lower ore body and drilled to a depth of 50 feet, only barren serpentine was struck. According to Durand A. Hall,⁴⁹ exploration in 1945, by drilling of the area immediately north of the lower ore body, located a new ore body.

Leitner Claim (19). The Leitner claim is in sec. 29, T. 29 S., R. 12 E., and adjoins the Castro mine on the northwest. Two small bodies of chromite in sheared serpentine were mined out during World War I.

Colorado Mine (23). The Colorado mine lies on the section line between sec. 32 and sec. 33, T. 29 S., R. 12 E., on the Castro mine road, about 5 miles from Goldtree Siding. In 1918 the property was owned in part by P. A. H. Arata and a Mr. Palmer, and in part by C. E. Walters. All mining activity took place during the 1880's, when a reported 1,200 long tons of chromite was produced. This figure is probably high, although the open cuts are large enough to account for such an amount. The ore came from four open cuts that have a northwesterly alignment over a distance of 400 feet. They were all caved in 1918, and no chromite was observed in place.

El Divisadero Mine (24). The El Divisadero mine is in the NW $\frac{1}{4}$ sec. 33, T. 29 S., R. 12 E., about 7 miles (direct line) northwest of San Luis Obispo. It is a patented claim that was listed in 1935 as belonging to the L. H. Butcher Co. of San Francisco. Some chromite was taken from two open cuts and two short tunnels at the southwesternmost occurrence, which is just above the road to the Castro mine. An occurrence 700 feet to the north is indicated by three open cuts, in one of which a stringer of ore is exposed, and a tunnel into the hill below the cuts. At a third occurrence, a band of disseminated chromite 4 feet wide is exposed in the larger of two pits. The dumps at these pits contain a considerable amount of siliceous, disseminated ore, from which the higher-grade shipping ore had been selected. A fourth occurrence, 600 feet north of the third, is marked by a cut 10 feet deep and 30 feet long, with a shaft at the deeper end; the cut is caved, and no chromite shows. The only production reported is about 5 tons, shipped in 1918. Most of it was material sorted out of the dumps and float collected from the hillside.

El Primero (La Primera) Mine (34). The El Primero mine is in sec. 33, T. 29 S., R. 12 E., 1,300 feet north of the New London mine. It is about a quarter of a mile east of the Castro mine road, and 5 miles by road from Goldtree Siding. The property consists of one patented claim owned by the L. H. Butcher Co., of San Francisco. A series of cuts around the nose of a hill has uncovered a nearly continuous stringer of chromite over a distance of almost 200 feet. The stringer is a few inches to 2 feet

⁴⁹ Oral communication, January, 1951.



FIGURE 4. Reclaiming dumps at the New London mine. *Photo by W. W. Bradley, 1943.*

wide; its strike swings from northeast to northwest and it dips irregularly toward the center of the curve. What is probably a continuation of the same stringer is exposed in a tunnel 40 feet below the cuts. The ore is soft, granulated, most commonly of the disseminated type. The mine was closed down in 1890, after a reported production of 300 tons. It was briefly active early in 1918, when 25 tons of 30 percent ore was shipped. It was again idle in July 1918, when Young visited the property, and has remained idle ever since.

El Salto Mine (24). The El Salto mine is in the S $\frac{1}{2}$ sec. 33, T. 29 S., R. 12 E., about 7 miles (direct line) northwest of San Luis Obispo, and just below the Castro mine road. It consists of one patented mining claim adjoining the southern end of the El Divisadero claim. All the chromite produced has been float washed from the surrounding hills and concentrated in the deep gully that crosses the claim. Most of the mining was during the 1880's; the only subsequent activity was in 1918, when a production of 13 tons was reported.

New London (London) Mine (34). The New London mine is in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, T. 29 S., R. 12 E., on the west side of a steep gully of a fork of Chorro Creek, at an altitude of 1,125 feet. It is owned by Mrs. Grace Thornberg, who leased it to the Castro Chrome Associates in 1943. They took 2,460 tons of material, which averaged about 6 percent Cr₂O₃, from the dumps (fig. 4); from this material the Castro mill recovered more than 200 long tons of concentrates. This, plus the 3,500 long tons of lump ore produced during World War I, and 41 long tons in 1936-37, makes a recorded total of about 3,750 long tons of ore and concentrates.

Young⁵⁰ visited the property in June 1918, when the underground workings were all open. In his field notes he described the ore body as a "large zone of disseminated ore of banded structure. The form of the zone and of the better bunches of ore in it are very irregular. The zone appears to be about 120 feet long, and 80 feet wide. Proven depth of 100 feet. General dip about 40° to the north. Strike is N. 65° W. A strong rake to the west in depth. . . . The ore is a granular disseminated chrome ore with a serpentine base. . . . The grade is sufficiently high to produce shipping ore and there are all grades present down to grades too poor to mill . . . and the general average of the ore in the mine as it would be mined for a mill is about 25 percent."

A plan of the underground workings of the New London mine has been published in a report by Smith and Griggs.⁵¹ All of the workings are caved and inaccessible.

Trinidad (La Trinidad) Mine (26). The Trinidad mine is in the NE $\frac{1}{4}$ sec. 33, T. 29 S., R. 12 E., on the southwest slope of the Santa Lucia Range, 3 $\frac{1}{2}$ miles by road from Goldtree Siding. The property is owned by S. L. Swartz, of San Francisco, who leased it to the Castro Chrome Associates in 1943. The old inclined shaft and part of the underground workings were then reopened (pl. 7), and 48 tons of massive ore was mined. The only ore observed in place in the reopened workings was in three small

⁵⁰ Young, E. L., op. cit.

⁵¹ Smith, C. T., and Griggs, A. B., op. cit., pl. 14.

exposures beneath the lagging in the open stope, and a stringer several inches wide and 8 feet long lying horizontally near the end of the drift. During 1943 and the first 4 months of 1944, about 4,600 wet short tons of dump material from the Trinidad was treated at the Castro mill; this material yielded 844 long tons of concentrates, which averaged 45 percent Cr_2O_3 and had a chromium-iron ratio of 3 to 1. The only other recorded production is 804 long tons of lump ore in 1918, making a total production of 852 tons of lump ore and 844 tons of concentrates. The mine is now idle.

Vulture Mine (10). The Vulture mine is in the NW $\frac{1}{4}$ sec. 2, T. 29 S., R. 11 E., on a steep hill of serpentine on the northwest side of Morro Creek. Very small pods of chromite occur in a northwest-trending zone in sheared serpentine. Less than a ton of ore had been dug out of this zone, over a distance of 50 feet and to a depth of 6 feet, when Young visited the mine in June 1918. Two tunnels, one 115 feet long and the other 85 feet long, were driven in barren serpentine.

Pick and Shovel Group

Pick and Shovel (Safety) Mine (32). The Pick and Shovel mine is in the SE $\frac{1}{4}$ sec. 34, T. 29 S., R. 12 E., near the headwaters of a branch of Chorro Creek, at an altitude of about 1,560 feet, about 6 miles by road from San Luis Obispo. It is owned by Mrs. Grace Thornberg. Large tonnages of chromite were produced from the Pick and Shovel mine between 1870 and 1917, but detailed records of production for this period are not available. The recorded production from 1918 to June 1944 is 2,079 long tons. A. H. Wilde and associates leased the property and in 1942 erected a small mill, in which they treated 95 tons of ore. In 1943 they subleased the property to Ralph Bisnett. Total production from 1942 to June 1944 was 151 long tons. All the recent mining has been done in a crosscut in the lowest tunnel, 100 feet from the portal, where remnants of an irregular zone of disseminated and massive ore are exposed. The zone apparently averaged about 6 feet in width, 40 feet in length and 12 feet in depth, and had a strike of N. 58° E. and a dip of 45° NW. At one place the ore has been stoped to the surface. A plan map of the underground workings of the Pick and Shovel mine and a geologic map of the surface are published in a report by Smith and Griggs.⁵² The mine is now idle.

Chorro (Chorro Creek, London) Mine (29). The Chorro mine is in the NE $\frac{1}{4}$ sec. 34, T. 29 S., R. 12 E., a quarter of a mile up the slope from the Pick and Shovel mine, at an altitude of about 2,050 feet. It is owned by Mrs. Grace Thornberg. According to Young, the deposit is a concentration of chromite float in the toe of a landslide, in which pieces of chromite have been found to a depth of 20 feet. Most of the ore recovered, however, has come from the surface and from shallow trenches. The mine was active in the years from 1870 to 1890 and in 1918; incomplete production records indicate that as much as 250 tons of ore may have been shipped from this deposit.

Sunshine (Alviso, Keeney) Claims (33). The Sunshine claims are in the S $\frac{1}{2}$ sec. 34, T. 29 S., R. 12 E., below the Pick and Shovel mine, and about 4 miles by road from Goldtree Siding. Several small showings of chromite lie within these claims, but considerable development work

⁵² Smith, C. T., and Griggs, A. B., op. cit., pls. 12 and 13.

during World War I discovered very little ore. According to Young, 39 tons of ore averaging 38 percent Cr_2O_3 was mined and shipped in 1917.

Other properties in the Pick and Shovel group include the *Cypress claim* (29), the *Single Jack mine* (31), and the *Rawhide* (23).

Seeley Group

The Seeley group consists of a number of properties including the Central claims (Climax or Liberty, Trout Creek No. 1 or New Discovery, Trout Creek No. 2, Spring Creek No. 1 or Lucky Jack or Lucky Jake) (28), and the Crown Point (18), Hilltop (21), Ore Bag (30), and Outpost or Old Glory (27) claims. They are located in T. 29 S., R. 12 E., in an area nearly 2 miles long on the crest of the Santa Lucia Range, in the large serpentinized ultramafic mass that is exposed about 6 miles north of San Luis Obispo (pl. 4). In 1944 the claims were held by C. L. Seeley and George Miller. The larger properties in the group have been described in some detail by Smith and Griggs.⁵³

Sweetwater-Norcross Group

The properties included in the Sweetwater-Norcross group are located near the crest of the Santa Lucia Range, about 6 miles north of San Luis Obispo. Properties in addition to those described below are the Eagle claim (12), Eucalyptus Nos. 1 and 2 claims (12), Captain deposit (14), Chromic Acid No. 2 claim (11), Colonel and Moonbeam No. 1 properties (12), and Tip Top deposit (11).

Eureka (Leslie Elberg) Claim (11). The Eureka claim is in sec. 11, T. 29 S., R. 11 E., adjoining the Sweetwater mine on the northwest. Young visited the property while development work was being done, and reported that there were faint showings of chromite in the trench and in the tunnel beneath it, but not a pound of ore.

Chromic Acid No. 1 (High Grade) Claim (11). The Chromic Acid No. 1 claim is in sec. 12, T. 29 S., R. 11 E. Young, in describing this deposit as the High Grade, reported that it was a new discovery in 1918. The lower showings were siliceous, and he estimated that the milling-grade ore contained 10 percent or more Cr_2O_3 .

Norcross (Biaggini) Mine (15). The Norcross mine (fig. 5) is in the NE $\frac{1}{4}$ sec. 13, T. 29 S., R. 11 E., on the southwest slope of the Santa Lucia Range. The mine is 16 miles by road from San Luis Obispo, of which 10.5 miles is paved, 3 miles is macadam, and 2 $\frac{1}{2}$ miles is mountain dirt road. The property is owned by the B. Biaggini Estate, which leased it in 1942 to E. C. Cazier and James A. Houlahan, of Beverly Hills. Prior to 1943 a production of 2,109 tons of ore, mostly concentrates, is credited to the Norcross mine. Much of this ore came from an open pit 100 feet long and from 10 feet to more than 50 feet wide. Production for 1943 and the first 5 months of 1944 was 407 tons, all lump ore that averaged 39 percent Cr_2O_3 and had a chromium-iron ratio of about 2.3 to 1.

During mining in 1943 and 1944, the open pit was lengthened to 200 feet. The long axis of the pit trends N. 30° E.; the pit is V-shaped and the face at the deeper, north end is 40 feet high. Two bodies of disseminated ore containing small, irregular pods and stringers of massive

⁵³ Smith, C. T., and Griggs, A. B., op. cit., pp. 42, 43.

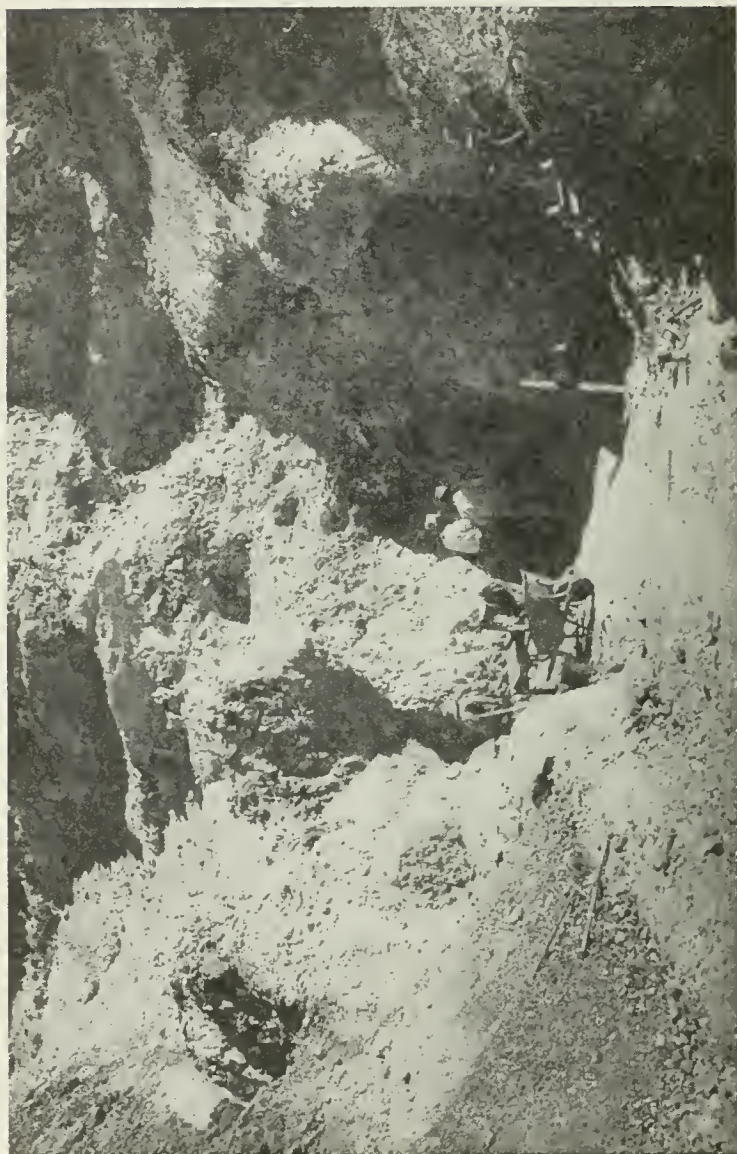


FIGURE 5. Norcross (Biagini) mine. Photo by W. W. Bradley, 1943.

chromite are exposed in the pit. A body of low-grade ore 40 feet south of the north end of the pit strikes N. 65° E. and dips almost vertically. Disseminated chromite can be traced for 50 feet along the strike, and is exposed to a height of 20 feet above the pit floor in the eastern wall, where the ore body is 2 to 8 feet wide. The other ore body is exposed discontinuously for about 40 feet in the floor along the east side of the pit. It appears to lie horizontally, has an average thickness of 4 feet, and, as exposed in two short tunnels, is at least 10 feet wide. It is apparent from Young's report that ore mined from the Victory No. 3 claim and the West Norcross mine during World War I were included in production figures for the Norcross.

Sweetwater (San Juan) Mine (11). The Sweetwater mine is in the SW $\frac{1}{4}$ sec. 12 and SE $\frac{1}{4}$ sec. 11, T. 29 S., R. 11 E., on the southwest slope of the Santa Lucia Range, at an altitude of 1,500 feet. It is owned by W. W. Pierce, of Morro. In 1942, a new road was built to the mine from San Bernardo Creek, and the mine can now be reached from San Luis Obispo by 10 $\frac{1}{2}$ miles of paved road, 3 miles of macadam road, and 3 miles of mountain dirt road. The mine is described by Smith and Griggs⁵⁴ as follows:

... Mining operations began in 1917, and up to 1941, 1,039 long tons of concentrates averaging 46 percent Cr₂O₃ has been shipped . . .

The mine workings comprise five open pits aligned in a N. 60° W. direction over a distance of 325 feet, five tunnel levels below and to the north of the pits, and a tunnel connecting the two easternmost pits with a crosscut from this tunnel to the surface. The aggregate length of chromite outcrops is 600 feet and their vertical range 150 feet. There is 1,400 feet of tunneling, with five small stopes from which pods of massive ore have been extracted. . . .

The chromite ore occurs in pods, in streaks due to post-mineral movement, in clots, and as discrete grains. The minable pods are elongate narrow bodies containing from less than a hundred to several hundred tons of massive ore. They are connected by zones containing grains and small clots of disseminated chromite, and remnants of the extracted pods grade abruptly into barren rock or disseminated ore.

The ore bodies are contained within a mass of serpentinized dunite, which is surrounded by peridotite; the dunite forms an irregular elongate body trending north-westward.

Sampling by the U. S. Bureau of Mines in 1941 indicated that the ore averages about 7 percent Cr₂O₃.

Victory No. 3 (Sunrise No. 3, Bernardo No. 3, Mazanita) Claim (15). The Victory No. 3 claim is in sec. 13, T. 29 S., R. 11 E., about 1,500 feet N. 20° W. of the Norcross mine. In December 1942 it was relocated by L. A. Moran, J. A. Houlahan, and E. C. Cazier. An open pit on the claim that is 125 feet long, 40 feet wide, and from 25 to 30 feet deep, suggests that large tonnages of chromite were mined prior to 1943, but there are no detailed production records available. In 1943, 28 tons of ore, having a Cr₂O₃ content of 40.8 percent and a chromium-iron ratio of 2.65 to 1, was mined from this claim, apparently from an old inclined shaft 25 feet north of the pit. The shaft has been dug at an angle of 40° eastward, down the dip of the ore zone to a depth of 20 feet. The ore zone dips eastward and is at least 5 feet wide. Nearly half of the chromite is almost massive, the remainder is disseminated. Only remnants of ore have been left in a stope 10 feet in diameter at the bottom of the shaft. Young visited the property in 1918. He reports that the deposit had been discovered earlier in the year and had been explored by six cuts for a distance of 85 feet; the ore zone had a thickness of about 8 feet.

⁵⁴ Smith, C. T., and Griggs, A. B., op. cit., pp. 36-37.

West Norcross (Brooklyn) Mine (15). The West Norcross mine is located between the Norcross mine and the Victory No. 3 claim, in sec. 13, T. 29 S., R. 11 E. It is owned by J. A. Houlahan and E. C. Cazier. The only recent work was done in 1943, when an old inclined shaft at the southeast end of the pit was reopened for 15 feet down the dip of the ore. The ore zone dips 45° to the northeast and averages about 2 feet in width; it consists of disseminated ore containing stringers and small pods of massive chromite. The ore pinches out at the foot of the shaft.

San Luis Obispo-Arroyo Grande Area

Donovan Ranch Deposit. The Donovan Ranch, owned by Agnes Donovan is on U. S. Highway 101, 2 miles southeast of Arroyo Grande. Young reported two small occurrences of chromite within an area of serpentine about an acre in extent.

Goldtree Vineyard Mine. The Goldtree Vineyard mine is 2 miles east of San Luis Obispo on the steep southwestern slope of a serpentine ridge. In 1917 several very small pods of chromite were taken out at this locality. No chromite can be seen in place; a few small pieces of float are scattered over the surface.

Isom Ranch Deposit. Some float and a small stringer of chromite were reported by Young, on the ranch of Dave Isom, $3\frac{1}{2}$ miles northeast of Edna.

Johnson Ranch Deposit (35). The Johnson Ranch deposit is in the $N\frac{1}{2}$ sec. 10, T. 30 S., R. 12 E., on the southwest slope of a ridge of serpentine 3 miles north of San Luis Obispo. Mrs. R. F. Johnson, of San Luis Obispo, owns the property. During World War I two stringers of chromite were mined out by means of two open cuts and two tunnels under the cuts. Only small remnants of the irregular ore bodies, which contained disseminated and massive ore, remain in the cuts. A third tunnel, 80 feet below the lower occurrence and 220 feet long, was dug in barren serpentine for its entire length. Total production was estimated at 40 long tons of rather low grade siliceous ore.

Lucky Strike Mine (36). The Lucky Strike mine is in sec. 19, T. 30 S., R. 13 E., on property belonging to H. Mehlman. It is on the west slope of a serpentine hill about 3 miles northeast of San Luis Obispo and a quarter of a mile east of U. S. Highway 101. The larger of two showings was a pod of massive chromite with sharp boundaries. It was 10 feet by 16 feet at its largest horizontal section, and was pinching out rapidly at a depth of 12 feet when seen by Young in July 1918. At that time, 80 long tons averaging 43 percent Cr_2O_3 had been mined from the pod. A quarter of a mile south of this pod, a stringer of nearly massive chromite, 1 foot wide, was exposed for a distance of 15 feet.

About 3 tons of float chromite was picked up on the east side of the same hill, on property belonging to Jack Low. About 200 feet of tunnels and 400 feet of open cuts were dug following up the float, but no chromite was found in place.

Steele Ranch (Rancho Santa Manuela) Deposit. The Steel Ranch deposit is 7 miles northeast of Arroyo Grande by road, the last mile of which is dirt. It is located on part of the old Santa Manuela land grant

belonging to Mrs. Susie Steele. Prior to World War I a reported 150 to 200 long tons of massive chromite was collected from the surface and taken out of several open cuts and short tunnels. Since that time there has been little or no work done on the deposit. Patches of disseminated ore still show in the two larger cuts, and considerable float is scattered over the southwest slope of the hill below the workings. The deposit occurs in an elongate mass of serpentinite, which is about 600 feet wide at this locality.

San Luis Range Area

Froom Ranch Deposit (38). The Froom Ranch deposit is on the east slope of Mine Hill, about 1 mile southeast of the Sousa Ranch deposits, and 3 miles southwest of San Luis Obispo (5 miles by road). The property belongs to John Froom, who leased it in 1942 to the Burdum Mining Co., (H. V. Burgard, president), of Riverside. At that time, an unsuccessful attempt was made to mine the residual deposit on the flat just below the old open cuts. This flat is 100 to 200 feet wide and 550 feet long, and has a soil mantle 1 foot to 2 feet thick. Chromite float, ranging in size from sand grains to boulders of several pounds, probably makes up 20 percent of the soil mantle.

Sousa Ranch Deposits. The Sousa Ranch deposits are near the top of Mine Hill, $3\frac{1}{2}$ miles (direct line) southwest of San Luis Obispo, but $7\frac{1}{2}$ miles by road. They are within the old Laguna land grant on property owned by Virginia L. Sousa, who leased them to Todd B. Elliot in 1942. Since that time, up to June 1944, 47 long tons of lump ore averaging 45 percent Cr_2O_3 , with a chromium-iron ratio of 3.2 to 1, has been produced. The total recorded production, for the World War I and World War II periods, is 83 long tons, which, from the amount of workings, appears to be but a small percentage of the total production. Most of the chromite was mined during the 1880's and early 1890's, but there are no available records of this early production. The workings consist of numerous open pits aligned along four parallel zones trending northwest, and two short tunnels. Apparently most of the ore was massive and occurred in pods having a vertical attitude. In two places, however, the ore was nodular.

Santa Barbara County

Except for reported occurrences near Point Sal, all the known chromite deposits in Santa Barbara County are restricted to the numerous northwest-trending serpentinite bodies exposed in the San Rafael Mountains (see fig. 1) between the Sisquoc and Santa Ynez Rivers (pl. 5). The serpentinite bodies occur in a belt of the Franciscan formation that extends N. 40° - 50° W. for nearly 30 miles from a point 6 miles north of Santa Barbara. This belt of Franciscan rocks has been mapped only in part, and therefore only the larger and more accessible serpentinite bodies have been delineated. It has been reported by T. W. Dibblee, Jr.,⁵⁵ however, that many smaller, unmapped masses of serpentinite occur in this belt. In some outcrops the serpentinite is so highly sheared and altered that the variety of original ultramafic rock cannot be determined. In other outcrops unaltered minerals and primary textures indicate that the serpentinite was derived from both saxonite and dunite.

⁵⁵ Written communication, 1951.

Production of 764 long tons of chromite is recorded for the county (table 2); much of this has been found on the surface as boulders and as detached masses in landslides. At the Bacon and Eagle mines and the Roberts claims, some disseminated ore and, locally, small bunches of massive chromite have been developed. Shipping of chromite has been limited mainly to two periods: in 1918, when 446 long tons of ore was produced, and from 1934 to 1942 when 318 long tons was shipped to the Columbia Steel Co.

*Bacon (O and B) Mine (5).*⁵⁶ The Bacon mine is in the NW $\frac{1}{4}$ sec. 7, T. 7 N., R. 29 W., in Corrales Canyon, at an altitude of about 2,100 feet. Gaviota, the nearest shipping point, is 34 miles, by road, to the southwest. J. F. Bacon, of Santa Barbara, who holds the property by location, shipped 36 long tons of ore that he picked up at the mine in 1942. It is reported that 870 long tons of ore was shipped during World War I; this, plus a small amount mined in 1934, would make a total production through 1942 of nearly 1,000 long tons; the recorded total, however, is only 488 long tons.

When the mine was visited in 1942, no recent work had been done and very little chromite could be seen in place. The most informative description of the mine is by Young,⁵⁷ who visited the mine in 1918, when it was being operated. He writes:

The ore body is a lenticular mass with a strike of N. 80° E. and a dip as high as 45° to the north. It is opened by an open cut, the face of which has been carried northward from creek level for about 20 feet. The floor of the open cut is about eight feet below the former outcrop of the ore body. The thickness of ore exposed now varies from a few inches to four feet.

The ore is largely high grade, but disseminated ore of a lower grade is present, the most noteworthy mass of which lies on the hanging wall side of the ore body near its west end. It is called 'birds-eye' ore by the miners and consists of rounded masses of pure chromite, up to one quarter of an inch in diameter in a matrix of green serpentine. . . .

. . . Across the creek, immediately south of the main working, a small amount of chromite has been found as pellets up to one half inch in diameter in yellow, decomposed serpentine. The pellets probably carry 30 percent Cr₂O₃ as considerable serpentine is contained within them.

About 150 feet above the main workings, small masses of high grade chromite have been found in the serpentine on the south bank of the creek. One hundred feet further, 'birds-eye' chrome of extremely coarse grain up to one inch diameter, has been found in small amounts.

Bull Run Prospect (3). The Bull Run prospect is in sec. 5 (?), T. 7 N., R. 29 W., about a mile north of the Bacon mine. The only chromite found on this claim was a 50-pound boulder lying on chert.

Eagle Mine (6). The Eagle mine is in sec. 10, T. 7 N., R. 29 W., on a ridge west of Cachuma Creek. It was located by C. E. Lee and associates, who worked it in 1918. Small bunches of massive and disseminated chromite occur within a zone of sheared serpentine, striking north and dipping 60° west. About 3 tons of rather poor grade shipping ore had been taken out of 30 feet of underground workings along this zone when Young⁵⁸ examined the mine in 1918. The deposit was considered unpromising because of the low grade and scattered distribution of the chromite.

⁵⁶ Numbers in parentheses refer to plate 5 and table 3.

⁵⁷ Young, E. L., Unpublished reports for U. S. Bureau of Mines (1918), in files of California Div. Mines.

⁵⁸ Young, E. L., op. cit.

Fairview (Acachuma, Los Olivos) Prospect (8). The Fairview prospect is in sec. 15, T. 7 N., R. 29 W., on the west side of Cachuma Creek. Chromite float was scattered over a large area, but none was seen in place when Young visited the prospect in 1918. A total of 16 tons was shipped from this prospect; 6 tons was float and 10 tons was taken from a pile near an old cut.

Montinero (La Laguna Ranch) Prospect (4). The Montinero prospect is in the south center of sec. 1, T. 7 N., R. 30 W., in Rancho La Laguna. It is about 1 mile northeast of the Bacon mine and is served by the same road. It was one of the chromite properties controlled by James O'Donnell and Robert Byrne during World War I. When E. L. Young visited the property in August 1918, about 40 tons of massive float chromite had been collected. The float was found in slide areas on three sides and near the top of a hill, within an area not more than 1,200 feet square. Some chromite cropped out in sheared serpentine just below the summit of the hill; this outcrop may have been the source of the float.

Roberts Claims. The Roberts claims—Pine Chrome, Look-out Chrome, and Fir Chrome—are in sec. 29 (?), T. 8 N., R. 29 W., on the steep ridge south of Sunset Valley, between Munch and Fir Canyons. They are held by location by H. L. Roberts and Nelson Taylor, of Santa Barbara. The claims are 68 miles from Gaviota by road: 20 miles paved, 33 miles gravel, and 15 miles Forest Service dirt road. Fourteen shallow cuts have been dug on these claims at places where float was found, but the only chromite seen in place occurred as small bunches in a shear zone in a 73-foot tunnel. The float probably came from the same shear zone in serpentine, but the bunches are small and so scattered that it is doubtful whether they merit further prospecting. In 1942 35 tons of massive float ore was shipped.

Zaca Lake Prospect (1). Zaca Lake prospect is in sec. 15, T. 8 N., R. 30 W., on the north side of Zaca Peak. A pod containing about 1 ton of chromite was mined out at this locality in 1918. Nothing more was found by further prospecting.

Other reported chromite occurrences in this area are the *Scrub Oak claim*, in the E $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 31, T. 8 N., R. 29 W.; *Red Bluff claim*, in sec. 32, T. 8 N., R. 29 W.; *Mesa claim*, in sec. 8, T. 7 N., R. 29 W., and *Chicken Spring claim*, in sec. 15, T. 7 N., R. 29 W.

Deposits in Vicinity of Point Sal. Although chromite deposits are reported to occur in the hills southwest of Point Sal, inquiries failed to elicit specific information, and no samples from this area were seen.

Santa Clara County

Topographically, Santa Clara County can be divided into three parts: the Diablo Range to the east, the Santa Cruz Mountains to the west, and the Santa Clara Valley, a down-faulted block lying between them (fig. 1). The valley is highly developed by roads and the Santa Cruz Mountains are accessible by a number of dirt and paved roads, whereas most of the Diablo Range is inaccessible to vehicles. Much of the valley floor is covered by alluvium, but in the foothills adjacent to the valley there are exposures of Tertiary and Cretaceous sedimentary rocks. South of San Jose, the alluvial belt narrows, and pre-Cretaceous rocks and associated

ultramafic intrusive rocks are exposed in the low-lying foothills adjacent to the valley floor. One narrow, attenuated, apparently continuous mass of serpentine extends for 18 miles along the eastern foothills from the town of Morgan Hill northward to the vicinity of San Jose. The mountainous region to the east of the Santa Clara Valley is known to contain large areas underlain by pre-Cretaceous rocks, but in this area little detailed geologic mapping has been done. One ultramafic mass nearly 8 miles long with a maximum width of $1\frac{3}{4}$ miles is crossed by the road in Canyon del Puerto (Puerto Creek) in the Diablo Range. This mass, which has been mapped in some detail, includes Red Mountain, the site of an important magnesite deposit that is described by Bodenlos.⁵⁹ It seems probable that other ultramafic bodies containing concentrations of chromite will be found in the remote mountainous areas.

The first recorded interest in the chromite deposits of Santa Clara County was in the early 1880's. This interest centered in the vicinity of the New Almaden and Guadalupe quicksilver mines, where prospectors continued to look for new deposits of cinnabar in the northwest-trending masses of serpentinized ultramafic rock that are characteristic of the region. Later, the field of exploration was extended to the serpentine masses lying southeast of the Almaden area, to the masses near Coyote, and to the extensive ultramafic sheet that crosses Red Mountain in the northeast corner of the county (pl. 2).

Production of chromite from Santa Clara County was small prior to World War I, probably totaling less than 200 long tons, though it is reported by Irean⁶⁰ that between 100 and 200 tons of ore was shipped from the Hahn Ranch deposits before 1888. In the period from 1915 to 1920, however, a number of mines and prospects were being operated and production both from ore in place and from float boulders totaled about 500 tons of chromite. Most of the ore contained less than 45 percent Cr_2O_3 , but locally small amounts contained as much as 54 percent Cr_2O_3 . No production has been reported since 1920, indicating that the chromite existing near the surface at these mines was probably exhausted.

Greenwalls Property. In 1896, T. B. Greenwalls owned a small chromite property in T. 9 S., R. 1 W., in the foothills west of the Southern Pacific Railroad about 16 miles south of San Jose. The deposit was developed by surface workings and a tunnel 60 feet long in sheared serpentine. Production probably totaled less than 150 tons for this property.

Hahn Ranch Deposits. On the Pueblo Lands of the City of San Jose, in T. 8 S., R. 1 E., about 12 miles south of the city, some 20 acres of land was prospected and worked for chromite by open cuts prior to 1888. It is reported that between 100 and 200 tons of ore was shipped from this property via the Guadalupe Narrow Gauge Railroad. Apparently the chromite occurred as stringers in a bluish sheared serpentine. One of these stringers is said to have been about 2 feet thick.

*Kilday Ranch Deposits (12).*⁶¹ The Kilday Ranch deposits are about 8 miles southeast of Los Gatos, Calif., in sec. 32, T. 8 S., R. 1 E., and sec. 5, T. 9 S., R. 1 E. These deposits were worked by open cuts and trenches

⁵⁹ Bodenlos, A. J., *Geology of the Red Mountain magnesite district, Santa Clara and Stanislaus Counties, California*: California Jour. Mines and Geology, vol. 46, no. 2, pp. 223-278, 1950.

⁶⁰ Irean, William, Jr., *op. cit.*, p. 549.

⁶¹ Numbers in parentheses refer to plate 2 and table 3.

from about 1915 to 1918 by M. J. Kilday. In 1916 about 80 tons of chromite was mined and shipped by the Farish Co. (lessor), of San Francisco. Total production probably amounts to 175 tons of chromite.

The chromite in these deposits commonly contained less than 45 percent Cr_2O_3 and occurred as small lenses and, locally, a few small stringers in sheared and decomposed serpentine.

Laurel Lake Ranch Deposits (13). J. A. Ferbrache, of Gilroy, developed deposits of chromite in sec. 20, T. 10 S., R. 3 E., on a serpentine ridge south of Uvas Creek. The deposits were worked by open cuts and adits. The first chrome ore was shipped in 1917, and by 1920 a total of about 196 tons had been sold.

Associated with the serpentine are olivine-rich peridotites, which are also somewhat serpentinized. Some chromite was found in the serpentine, though early production was from boulders found on the slope below the serpentine ridge.

Western Magnesite Co. Property. In 1918 W. Balkan was operating chromite deposits under a lease on the property of the Western Magnesite Co. The deposits occur near the summit of Red Mountain in sec. 4, T. 6 S., R. 5 E., about 35 miles by road from Livermore (pl. 8). There is no record of the amount of ore shipped, but in 1918 about 20 tons of ore containing 35 percent Cr_2O_3 had been mined from a pit on this property.

The chromite occurs as granular stringers and disseminated grains in partly serpentinized dunite lenses. The dunite lenses are in a peridotite mass that trends northwest across the summit of Red Mountain. The deposits are small and the chromite is of low grade.⁶²

Winship Properties (1). The Winship properties, owned by the K. D. Winship Estate and operated by various lessees, are located in the SW $\frac{1}{4}$ sec. 7, T. 6 S., R. 5 E. and in sec. 11 and 12, T. 6 S., R. 4 E. The nearest railroad shipping point is Livermore, 30 miles northwest by the Arroyo Mocho road. The chromite ore, most of which contained less than 35 percent Cr_2O_3 , was found in several localities. The ore occurred in serpentine as stringers and lenses; some of the lenses were as much as 1 foot thick. The deposits were developed mainly by open cuts, though some underground mining was done to explore beneath outcrops of chromite. In the summer of 1917, Holbrook & McGuire (sublessees) are reported to have shipped several carloads of ore from this property, though some or all of this ore may have come from just across the boundary in Stanislaus County. T. S. O'Brien of San Francisco, leased the deposits in sec. 11 and in September 1918 constructed a 50-ton concentrating mill. Probably not more than 290 long tons of ore has been produced from these properties, though it is reported that 245 long tons was shipped in 1917.

Santa Cruz County

The only production of chromite recorded from Santa Cruz County has been from the concentration of beach sands.⁶³ In 1918, the Seashore Metals Syndicate was operating a 125-ton magnetic-separation plant on the beach approximately 8 miles north of Watsonville. During a

⁶² Bodenlos, A. J., op. cit., p. 274.

⁶³ Boalich, E. S., Manganese and chromium: California State Min. Bur., Prelim. Rept. 3, 2d ed., p. 34, 1918.

working day, about 5 tons of chrome concentrate was recovered, which averaged 48 percent Cr_2O_3 and less than 1 percent SiO_2 . Other materials that were being recovered included magnetite, titanium, gold, and platinum.

Stanislaus County

Chromite was discovered in western Stanislaus County (pl. 2) shortly before 1916, and has been mined intermittently since that time. Most of the production from this county came from mines in a peridotite mass in the Del Puerto area in T. 6 S., R. 5 E. The chromite deposits of the Del Puerto area have been completely described in a recent report by Hawkes, Wells, and Wheeler.⁶⁴

Total production from the Del Puerto area during the period 1916-1918 was about 3,600 tons of ore containing 40 percent or more Cr_2O_3 and 2,000 tons of milling ore averaging 20 percent Cr_2O_3 . Most of the milling ore was treated at the Chrome Concentrating Co. mill, which was owned by F. E. Harrison, W. R. Struck, and J. T. Carter, of San Francisco. The mill was 21 miles west of Patterson. There is no record of chromite production in the county from 1919 to 1939; in 1940 and 1941 a total of 178 tons of ore was shipped.

During World War I the chromite was shipped via the Patterson & Western Railroad to Patterson which is located on the Southern Pacific Railroad. In 1941, the Patterson & Western was no longer in operation and the area was accessible only by way of a graded dirt road from Patterson, the shipping point for the mines.

All the more productive chromite mines are located in a body of ultramafic rocks 8 miles long and approximately $1\frac{1}{2}$ miles wide, which consists of dunite, peridotite, pyroxenite, serpentine derived from these rocks, and intrusive gabbro. The ultramafic mass trends N. 70° W. across Red Mountain on the Stanislaus-Santa Clara county line. The well-known Red Mountain magnesite deposits, as well as occurrences of chromite, are located, in this mass, on the west slope of Red Mountain in Santa Clara County. Canyon del Puerto (Puerto Creek), in Stanislaus County, transects the ultramafic mass to a depth of 2,600 feet, exposing a good section of the mass and thereby permitting Hawkes⁶⁵ to map in detail the dunitic members of the ultramafic complex which contain the chromite deposits. Much of the remainder of the ultramafic mass has been mapped in a more general way by Bodenlos,⁶⁶ so that its geology is well known (pl. 8). Throughout most of its periphery the body is in fault contact with the Franciscan formation, but it is believed to be truly intrusive into the Franciscan. Along part of the eastern margin, the ultramafic body is covered by overlapping Cretaceous sedimentary rocks. Apparently the body lies in the crest of an anticline of Franciscan rocks, but the mapping by Hawkes shows that the southern contact, which shows fault relationships, dips steeply across the Franciscan structure. High-grade massive and granular chromite occurs as pods and irregular bodies in zones of shearing; lower-grade chromite occurs as grains disseminated in the serpentized dunite. Locally, tiny crystals of uvarovite are found as coatings on slickensided fractures in the chromite.

⁶⁴ Hawkes, H. E., Jr., Wells, F. G., and Wheeler, D. P., Jr., Chromite and quicksilver deposits of the Del Puerto area, Stanislaus County, California: U. S. Geol. Survey Bull. 936-D, pp. 79-110, 1942.

⁶⁵ Hawkes, H. E., Jr., Wells, F. G., and Wheeler, D. P., Jr., op. cit., pl. 10.

⁶⁶ Bodenlos, A. J., op. cit., pl. 38.

Five of the six largest producers in the Del Puerto area—the Adobe Canyon and Black Bart groups, and the Black Bear, Lucky Girl, and No. 5 mines—were held by the West Coast Chrome Co., of San Francisco in 1940, though all these properties were active under other owners or operators in the years 1916 to 1919.

*Adobe Canyon Group (McGuire et al. Deposits, or Mountain View and Gray Fox Claims) (6).*⁶⁷ The Adobe Canyon group, formerly known as the McGuire et al. deposits or the Mountain View and Gray Fox claims, is located in the SW $\frac{1}{4}$ sec. 14, the SE $\frac{1}{4}$ sec. 15, and the NE $\frac{1}{4}$ sec. 22, T. 6 S., R. 5 E., on the northeast side of Adobe Creek. The property was worked under a lease during World War I, when it was at the height of its production, by the Holbrook, McGuire & Springer Co., of San Francisco. At that time, development consisted of a number of short adits and open cuts; at the time of the U. S. Geological Survey investigation in 1940, most of the workings had ceased. Total production from the property is said to have been about 500 tons of ore.

A fairly large body of low-grade chromite, consisting of disseminated grains in the serpentinized dunite, is said to have contained 25 to 30 percent Cr₂O₃. Contained in this body of low-grade material were lenses and irregular masses of higher-grade ore. Production came both from sorted high-grade material and from the concentration of the lower grade ore.

Black Bart Group (3). In 1941 the West Coast Chrome Co., of San Francisco, held the chromite property known as the Black Bart group. The deposits are in sec. 16, T. 6 S., R. 5 E., on the north side of Hideout Creek, and are probably the same deposits that were worked in 1918 by J. H. Platner. The property was exploited by open pits, five short adits, and some underground stoping on a shear zone in serpentine. The shear zone strikes approximately east, and dips north at angles ranging from 40° to 80°. Most of the chromite is in massive blocks mixed with barren serpentine along the zone of shearing; the ore-bearing zone is continuous, but it varies in width between 1 foot and 6 feet. A total of 414 tons of chromite containing about 35 percent Cr₂O₃ is said to have been produced from these deposits.

Black Bear Mine (7). The Black Bear mine, in the central part of sec. 22, T. 6 S., R. 5 E., was held in 1941 by the West Coast Chrome Co. The mine was worked mainly in 1918, and a total of about 342 tons of ore averaging 50 percent Cr₂O₃ was produced.

Workings consisted of open pits, adits, and some narrow stopes, which explored along an east-striking shear zone in dunite. The ore body averaged approximately 18 inches in width throughout most of the stoped areas.

Chrome Camp Mine (4). In 1917 the Mineral Products Co., of San Francisco, operated a property, known in 1941 as the Chrome Camp mine, located in the southern part of sec. 11, T. 6 S., R. 5 E. Chromite was mined from two separate deposits on opposite sides of a hill about 400 feet above Puerto Creek. A total of 930 tons of ore averaging about 40 percent Cr₂O₃ is said to have been produced from the property.

⁶⁷ Numbers in parentheses refer to plate 2 and table 3.

At present no ore is visible in the workings, but both Young⁶⁸ and Hawkes, Wells, and Wheeler⁶⁹ indicate that the ore was localized along shear zones, one of which is located on the contact between ultramafic rocks and the Franciscan formation.

Lucky Girl Mine (8). Young⁷⁰ reported that in 1918 about 150 tons of ore averaging 42 percent Cr_2O_3 had been shipped from the Lucky Girl mine, which is located in the northwest corner of sec. 22, T. 6 S., R. 5 E., on the north side of Peachtree Creek in the Del Puerto area. At that time the property was owned by Mrs. Z. Vaughan, of Turlock, and was being operated by P. L. Finster, of Patterson. In 1941 the mine was held by the West Coast Chrome Co.

The deposit was worked by open cuts and short adits along a shear zone trending N 80° E. in a septum of dunite between peridotite and the Franciscan formation. Lenses and pods of granular and massive chromite as much as 2 feet thick occur in the shear zone, which extends for a distance of 500 feet.

No. 5 Mine (5). During World War I, the Mineral Products Co., of San Francisco, developed a chromite property located in secs. 14 and 15, T. 6 S., R. 5 E., on the slopes of Canyon Del Puerto immediately north-east of the junction of Puerto Creek and Adobe Creek. In 1941 the property was known as the No. 5 mine and was held by the West Coast Chrome Co. The property contained five bodies of chromite; the two largest were lenses of massive chromite from which the Mineral Products Co. is said to have produced about 1,200 tons of shipping ore. A considerable quantity of lower-grade ore was also mined from this property and concentrated by the Chrome Concentrating Co. mill; about 270 tons of concentrate averaging 51 percent Cr_2O_3 was produced from this ore.

The ore occurs as lenses of massive chromite, ranging from a few inches to a few feet in thickness, and as disseminated tabular bodies, in dunite. Most of the workings are open pits, though adits and stopes have been driven on some of the more extensive lenses.

REFERENCES

- Allen, J. E., Geological investigations of the chromite deposits of California: California Jour. Mines and Geology, vol. 37, pp. 101-167, 31 figs., 1941.
 Allen, J. E., Geology of the San Juan Bautista quadrangle, California: California Div. Mines Bull. 133, pp. 9-75, 8 pls., 10 figs., 1946.
 Bailey, E. H., unpublished map, U. S. Geol. Survey, 1948.
 Bailey, E. H., and Myers, W. B., Quicksilver and antimony deposits of the Stayton district, California: U. S. Geol. Survey Bull. 931-Q, pp. 405-434, 4 pls., 4 figs., 1942.
 Bailey, E. H., Quicksilver deposits of the Parkfield district, California: U. S. Geol. Survey Bull. 936-F, pp. 143-169, 4 pls., 1 fig., 1942.
 Bell, G. L., A geologic section of the Santa Lucia Mountains, Coast Range, California: Univ. California, unpublished thesis (M.A.), (1940).
 Boalich, E. S., Manganese and chromium: California State Mining Bur., Prelim. Rept. 3, 2d ed., 46 pp., 1918. (Chromium, pp. 23-40.)
 Bodenlos, A. J., Geology of the Red Mountain magnesite district, Santa Clara and Stanislaus Counties, California: California Jour. Mines and Geology, vol. 46, no. 2, pp. 223-278, 1950.
 Bradley, W. W., et al., Manganese and chromium in California: California State Min. Bur. Bull. 76, 248 pp., 1918. (C. A. Logan, Chromium, pp. 101-228.)

⁶⁸ Young, E. L., Unpublished reports for U. S. Bureau of Mines (1918), in files of California Div. Mines.

⁶⁹ Hawkes, H. E., Jr., Wells, F. G., and Wheeler, D. P., Jr., op. cit., p. 104

⁷⁰ Young, E. L., op. cit.

- Branner, J. C., Newsom, J. F., and Arnold, Ralph, U. S. Geol. Survey Geol. Atlas. Santa Cruz folio (no. 163), 11 pp., maps, 1909.
- Burchard, E. F., The production of chromic iron ore in 1909: U. S. Geol. Survey, Min. Resources, 1909, part 1, pp. 591-593, 1911.
- Crawford, J. J., California Mining Bur. Rept. 13, 726 pp., map, 1896. (Chromite, pp. 48-50.)
- Crittenden, M. D., Jr., Geology of the San Jose-Mt. Hamilton area, California: California Div. Mines Bull. 157, 74 pp., 11 pls., 14 figs., 1951.
- Dibblee, T. W., Jr., Geology of southwestern Santa Barbara County, California: California Div. Mines Bull. 150, pp. 1-95, 1950.
- Dibblee, T. W., Jr., Unpublished maps.
- Diller, J. S., Chromite in 1918: U. S. Geol. Survey, Min. Resources, 1918, part 1, pp. 657-679, 1 fig. 1921.
- Eckel, E. B., Yates, R. G., and Granger, A. E., Quicksilver deposits in San Luis Obispo County and southwestern Monterey County, California: U. S. Geol. Survey Bull. 922-R, pp. 515-580, 10 pls., 9 figs., 1941.
- Eckel, E. B., and Myers, W. B., Quicksilver deposits of the New Idria district, San Benito and Fresno Counties, California: California Jour. Mines and Geology, vol. 42, no. 2, pp. 81-124, 13 pls., 9 figs., 1946.
- Everhart, D. L., Quicksilver deposits of the Cachuma district, Santa Barbara County, California: California Jour. Mines and Geology, vol. 46, no. 4, pp. 509-532, 1 fig., 5 pls., 1950.
- Fairbanks, H. W., Geology of Point Sal, Santa Barbara County, California: Univ. California Dept. Geol. Sci. Bull., vol. 2, no. 1, pp. 1-91, map, 1896.
- Fairbanks, H. W., U. S. Geol. Survey Geol. Atlas, San Luis folio (no. 101), 14 pp., maps, 1904.
- Fiedler, W. M., Geology of the Jamesburg quadrangle, Monterey County, California: California Jour. Mines and Geology, vol. 40, no. 2, pp. 177-250, 2 pls., 32 figs., 1944.
- Field reports on chromite deposits of California: made for California Div. Mines by various field engineers in period 1915-1919. Unpublished; on file at office of California Div. Mines.
- Franke, H. A., Mines and mineral resources of San Luis Obispo County, California: California Jour. Mines and Geology, vol. 31, no. 4, pp. 402-461, 1 pl., 16 figs., 1935.
- Hamilton, Fletcher, California State Mining Bur. Rept. 17, 562 pp., 9 pls., 62 figs., 1921. (Chromite, p. 172.)
- Hanks, H. G., California State Min. Bur. Rept. 4, 410 pp., 1884. (Chromium, pp. 129-139.)
- Harder, E. C., The production of chromic iron ore in 1908: U. S. Geol. Survey, Mineral Resources, 1908, part 1, pp. 751-770, 1909.
- Harder, E. C., Some chromite deposits in western and central California: U. S. Geol. Survey Bull. 430, part 1, pp. 167-183, 1910.
- Hawkes, H. E., Jr., Wells, F. G., and Wheeler, D. P., Jr., Chromite and quicksilver deposits of the Del Puerto area, Stanislaus County, California: U. S. Geol. Survey Bull. 936-D, pp. 79-110, 12 figs. incl. maps, 1942.
- Huey, A. S., Geology of the Tesla quadrangle, California: California Div. Mines Bull. 140, 75 pp., 11 pls., 3 figs., 1948.
- Huguenin, Emile, Santa Barbara County: California Mining Bur. Rept. 15, pp. 727-750, 1917. (Chromite, p. 735.)
- Ireland, William, Jr., California State Min. Bur. Rept. 8, 946 pp., 1888.
- Ireland, William, Jr., California State Min. Bur. Rept. 10, 983 pp., maps, 1890. (Chromite, pp. 582, 601.)
- Jenkins, O. P., ed., Geologic map of California, six sheets, scale 1:500,000, California Div. Mines, 1938.
- Kramm, H. E., Serpentes of the central Coast Ranges of California: Am. Ph. Soc., Proc., vol. 49, pp. 315-349, map, 1910.
- Laizure, C. McK., Contra Costa County: California State Min. Bur. Rept. 23, pp. 2-31, 1927. (Chromite, p. 12.)
- Lawson, A. C., U. S. Geol. Survey Geol. Atlas, San Francisco folio (no. 193), 24 pp., 1914.
- Leith, C. J., Geology of the Quien Sabe quadrangle, California: California Div. Mines Bull. 147, pp. 7-35, 7 pls., 1949.
- Logan, C. A. (See Bradley, W. W.)
- Reed, R. D., Geology of California: Am. Assoc. Petroleum Geologists, 355 pp. 60 figs., incl. maps, 1933.
- Reiche, Parry, Geology of the Lucia quadrangle, California: Univ. California, Dept. Geol. Sci. Bull., vol. 24, pp. 115-168, 3 pls., 11 figs., 1937.

- Ross, C. P., Quicksilver deposits of the Mount Diablo district, Contra Costa County, California: U. S. Geol. Survey Bull. 922-B, pp. 31-54, 3 pls., 2 figs., 1940.
- Rynearson, G. A., Chromite deposits of Tulare and eastern Fresno Counties, California: California Div. Mines Bull. 134, part 3, chap. 3, pp. 61-104, illus., 1948.
- Sampson, E., Chromite in 1921: U. S. Geol. Survey, Mineral Resources, 1921, part 1, pp. 15-17, 1922.
- Smith, C. T., and Griggs, A. B., Chromite deposits near San Luis Obispo, San Luis Obispo County, California: U. S. Geol. Survey Bull. 945-B, pp. 23-44, 9 pls., 4 figs., 4 tables, 1944.
- Smith, M. C., and Ricker, S., Chromite deposits: Sweetwater, Castro, Trinidad, New London, and Hilltop mines, San Luis Obispo County, California: U. S. Bur. Mines Rept. of Investigations 4783, pp. 1-7, 9 figs., 1951.
- Stanford University Dept. of Geology, Geologic map of the Pleasanton quadrangle, California: Summer Field Course, 1914, unpublished.
- Taliaferro, N. L., Geologic history and structure of the central Coast Ranges of California: California Div. Mines Bull. 118, pp. 119-163, 1941.
- Taliaferro, N. L., Geology of the Hollister quadrangle, California: California Div. Mines Bull. 143, in press. Geologic map of quadrangle published 1949.
- Taliaferro, N. L., Unpublished maps of the Cape San Martin, Bryson, San Simeon, Adelaida, and Nipomo quadrangles, California; some of these are reconnaissance only.
- Thomas, R. G., U. S. Bureau of Reclamation, unpublished map, 1949.
- Trask, P. D., Geology of the Point Sur quadrangle, California: Univ. California, Dept. Geol. Sci. Bull., vol. 16, pp. 119-186, 1 pl., 2 figs., 1926.
- Turner, H. W., The geology of Mount Diablo, California: Geol. Soc. America Bull., vol. 2, pp. 383-402, 1 pl., 3 figs., 1891.
- Walker, G. W., Sierra Blanca limestone in Santa Barbara County, California: California Div. Mines, Special Rept. 1-A, pp. 3-5, 1 pl., 1950.
- Waring, C. A., Petroleum industry of California: California State Min. Bur., map folio accompanying Bull. 69, pls., II-V, 1915.
- Weaver, C. E., Geology and mineral deposits of an area north of San Francisco Bay, California: California Div. Mines Bull. 149, pp. 3-135, 4 figs., 24 pls., 1949.
- Whitney, J. D., Geological survey of California; Geology, vol. I, Report of progress and synopsis of field work from 1860 to 1864, 498 pp., 1865.
- Wilson, I. F., Geology of the San Benito quadrangle, California: California Jour. Mines and Geology, vol. 39, no. 2, pp. 183-270, 1 pl., 30 figs., 1943.
- Yates, R. G., and Hilpert, L. S., Quicksilver deposits of central San Benito and northwestern Fresno Counties, California: California Jour. Mines and Geology, vol. 41, no. 1, pp. 11-35, 5 pls., 3 figs., 1945.
- Young, E. L., Unpublished reports for U. S. Bur. Mines (1918), in files of California Div. Mines.

TABLE 3, ALPHABETICAL LIST, BY COUNTIES, OF CHROMITE DEPOSITS
IN THE SOUTHERN COAST RANGES OF CALIFORNIA.

Alameda County

Map number ^a (P. 1)	Property ^b	Owners or shippers ^c	Location ^d			Class by produc- tion ^e	Source of data ^f
			Section	Town- ship	Range		
1	Cedar claim..... Cedar Mountain claim: See Newman..... Clark claim..... Douglas mine.....	J. H. Hardin..... Vernon Clark (O)..... D. Mendenhall (O)..... Tuohy and Wiggins (S) Peter Draghi (O)..... C. L. and L. W. Jones (O)..... E. N. Percy.....	S $\frac{1}{2}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ 26 S $\frac{1}{2}$ 26 SW $\frac{1}{4}$ 26 4 6 26	4 S. 4 S. 4 S. 5 S. 5 S. 4 S.	3 E. 3 E. 3 E. 3 E. 3 E. 3 E.	D C A? C? C D	Logan, D.M. Bull. 76, p. 115, 1918. Ireland, D.N.I., S.M.R. VIII, p. 32, 1888. Diller, J. S., M.R.U.S., p. 661, 1921. Harder, G.S., M.R.U.S., p. 767, 1909.
3	Manzanita Grove..... Mendenhall: See Newman Newman mine.....	S. V. Newman (O).....	SE $\frac{1}{4}$ 26	4 S.	3 E.	A	Logan, D.M. Bull. 76, pp. 115-116, 1918. Harder, G.S. Bull. 430, pp. 173-174, 1910. Logan, D.M. Bull. 76, p. 216, 1918.
5	Olsen mine..... Pine Grove.....	Ole Olson (O)..... Mrs. H. V. Mendenhall.....	S $\frac{1}{2}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ 26	4 S.	3 E.	D	

Fresno County, Western Part

Map number ^a (P. 1)	Property ^b	Owners or shippers ^c	Location ^d			Class by produc- tion ^e	Source of data ^f
			Section	Town- ship	Range		
10	Blue Diamond..... Cordon Peak: See Jeanne mine Joacine mine..... Rhodes, Byle and Gribble..... Tromby Nos. 1 and 2.....	N. H. Joyner..... Aurora Quicksilver Co..... Rhodes et al. (O)..... Aurora Quicksilver Co. (O ?).....	36 36 367	18 S. 18 S. 18 S.	12 E. 12 E. 12 E.	C C C C	Rynearson, D.M. Bull. 134, part III, Chap. 3, p. 99, 1948. Young, B.M. unpub., 1918. Logan, D.M. Bull. 76, pp. 144-145, 1918. Rynearson, D.M. Bull. 134, part III, Chap. 3, p. 102, 1948.

TABLE 3. ALPHABETICAL LIST, BY COUNTIES, OF CHROMITE DEPOSITS
IN THE SOUTHERN COAST RANGES OF CALIFORNIA—Continued.

Monterey County

Map number ^a (Pl. 3)	Property ^b	Owners or shippers ^c	Location ^d			Class by produc- tion ^e	Source of data ^f
			Section	Town- ship	Range		
12	Daisy (Aldabran).....	S. M. Mingus (O) or A. Egennes (O).....	SW $\frac{1}{4}$ 29	23 S.	6 E.	D?	Young, B.M. unpub., 1918. Logan, D.M. Bull. 76, p. 156, 1918.
13	Evans Ranch.....	W. J. and J. C. Evans (O).....	NW $\frac{1}{4}$ 26	24 S.	6 E.	D	Young, B.M. unpub., 1918. Logan, D.M. Bull. 76, p. 156, 1918.

San Benito County

Map number ^a (Pl. 3)	Property ^b	Owners or shippers ^c	Location ^d			Class by produc- tion ^e	Source of data ^f
			Section	Town- ship	Range		
4	Alpine deposit.....	John Mueller.....	13	18 S.	11 E.	D	Young, B.M., unpub., 1918.
3	Aurora (quicksilver) mine.....	S. Soyser (O)..... E. T. Hahn (S)	5	18 S.	12 E.	B	Young, B.M. unpub., 1918.
2	Buena Vista prospect.....	Silverstar Tirado..... H. Fowler.....	6	18 S.	12 E.	D	Young, B.M., unpub., 1918.
6	Elma Queen.....	J. W. Harrison (O).....	17, 20	18 S.	12 E.	C?	Young, B.M., unpub., 1918.
5	Harrison deposit.....	K. J. Hines (O).....	7, 8, 17	18 S.	12 E.	C	
1	Hines deposits.....	Anna Frits et al.....	36	14 S.	7 E.	D	
8	Ingalls.....	A. M. McCray et al. (O).....	16, 21, 22	18 S.	12 E.		Young, B.M., unpub., 1918.
	McCray property.....	Ramon Tirado.....	11, 12, 18	18 S.	12 E.		Young, B.M., unpub., 1918.
9	San Domingo Palto.....		22	18 S.	12 E.		
	Santa Rita.....	Joseph Tirado (O ?).....				C	
	Tirado Chrome mine.....	J. J. Blackie.....	20	18 S.	12 E.	C	Young, B.M., unpub., 1918.
7	Trinity deposit.....	Valdez Bros. (O ?).....				C	
	Valdez Bros. Chrome mine.....						

San Luis Obispo County

Map number ^a (Pl. 4)	Property ^b	Owners or shippers ^c	Location ^d			Class by production ^e	Source of data ^f
			Section	Township	Range		
14 19	Captain Castro mine (Castro group).....	Castro Chrome Associates.....	13 NW 1/4 SE 1/4 29	29 S. 29 S.	11 E. 12 E.	C? A	Allen, D.M., vol. 37, p. 143, 1941. Smith and Griggs, G.S. Bull. 945-B, pp. 34-35, 1944. Logan, D.M. Bull. 76, p. 167, 1918. Allen, D.M., vol. 37, p. 144, 1941.
20	Castro No. 2 (Castro group).....	.....	NE 1/4 SE 1/4 29	29 S.	12 E.	C?	Smith and Griggs, G.S. Bull. 945-B, p. 36, 1944.
28	Central claims (Climax or Liberty, Trout Creek No. 1 or New Discovery, Trout Creek No. 2, Spring Creek No. 1 or Lucky Jack or Lucky Jake claims) Chisholm mine: See Pine Mountain claims Chorro (Chorro Creek, London)	C. L. Seeley and G. Miller (O) Mrs. G. Thornberg (O).....	Near common corner of secs. 26, 27, 34, and 35 NE 1/4 34	29 S. 29 S.	12 E. 12 E.	B? C?	Smith and Griggs, G.S. Bull. 945-B, p. 42, 1944. Young, B.M. unpub., 1918.
11 11 17	Chronic Acid No. 1 (High Grade) Chronic Acid No. 2 Cienega	W. W. Pierce (O) W. W. Pierce (O) Pete Quintana (O).....	12 12 1 1/4 miles E. of Morro; 1/4 mile N. of State Hwy. No. 1	29 S. 29 S. 29 S.	11 E. 11 E. 11 E.	? ? C?	Young, B.M., unpub., 1918. Allen, D.M., vol. 37, p. 141, 1941; Young, B.M. unpub., 1918. Allen, D.M., vol. 37, p. 141, 1941. Young, B.M. unpub., 1918.
23	Colonel Colorado	Grace Beers	13 32, 33	29 S. 29 S.	11 E. 12 E.	? A?	Allen, D.M., vol. 37, p. 143, 1941. Logan, D.M. Bull. 76, p. 170, 1918. Young, B.M., unpub., 1918.
18	Crown Point	C. Seeley and G. Miller (O).....	SE 1/4 21	29 S.	12 E.	B	Smith and Griggs, G.S. Bull. 945-B, p. 43, 1944.
29	Cypress	.....	34	29 S.	12 E.	C	Smith and Griggs, G.S. Bull. 945-B, p. 40, 1944. Logan, D.M. Bull. 76, p. 170, 1918. Young, D.M. unpub., 1918.
12	Donovan Ranch Eagle	Agnes Donovan (O) W. W. Pierce (O).....	Near U.S. Hwy. No. 101, 2 miles SE. of Arroyo Grande 12 | 29 S. | 11 E.			? C?	Allen, D.M., vol. 37, p. 141, 1941.

TABLE 3, ALPHABETICAL LIST, BY COUNTIES, OF CHROMITE DEPOSITS
IN THE SOUTHERN COAST RANGES OF CALIFORNIA—Continued.

San Luis Obispo County—Continued

Map number ^a (Pl. 4)	Property ^b	Owners or shippers ^c	Location ^d			Class by produc- tion ^e	Source of data ^f
			Section	Town- ship	Range		
24	El Divisadero.....	L. H. Butcher Co. (O).....	NW $\frac{1}{4}$ 33	29 S.	12 E.	C	Young, B.M. unpub., 1918; Logan, D.M. Bull. 76, p. 170, 1918.
34	El Primero (La Primera).....	L. H. Butcher Co. (O).....	33	29 S.	12 E.	B?	Young, B.M. unpub., 1918.
	El Salto.....	L. H. Butcher Co. (O).....	SE $\frac{1}{2}$ 33	29 S.	12 E.	C?	Young, B.M. unpub., 1918; Logan, D.M. Bull. 76, p. 170, 1918.
22	Estrella.....	.....	On line be- tween secs. 28 and 29	29 S.	12 E.	A?	Smith and Griggs, C.S. Bull. 945-B, p. 36, 1944.
12	Eucalyptus No. 1.....	W. W. Pierce (O).....	SW $\frac{1}{4}$ 12	29 S.	11 E.	C?	Allen, D.M., vol. 37, p. 161, 1941. Smith and Griggs, G.S. Bull. 945-B, p. 38, 1944.
12	Eucalyptus No. 2.....	W. W. Pierce (O).....	12	29 S.	11 E.	?	Allen, D.M., vol. 37, pp. 141-142, 1941.
11	Eureka (Leslie Elberg).....	.....	11	29 S.	11 E.	?	Allen, D.M., vol. 37, p. 142, 1941. Young, B.M. unpub., 1918.
	Fitzhugh Ranch (Benton).....	William Fitzhugh and son (O).....	12 miles E. of Cambria	.....	.....	C?	Allen, D.M., vol. 37, pp. 140-141, 1941. Young, B.M. unpub., 1918.
	Froom Ranch.....	John Froom (O).....	3 miles SW. of San Luis Obispo	.....	.....	?	Frank, D.M., vol. 31, p. 412, 1935. Smith and Griggs, G.S. Bull. 945-B, p. 44, 1944.
	Goldtree Vineyard.....	Goldtree Investment Co. (O).....	2 miles E. of San Luis Obispo	.....	.....	C?	Logan, D.M. Bull. 76, p. 170, 1918. Young, B.M. unpub., 1918.
	Harris claims.....	W. R. Harris (O).....	6 and 7 miles S. of Sands Ranch	.....	.....	?	Young, B.M. unpub., 1918.
21	Hilltop.....	C. L. Seeley and G. Miller (O).....	28	29 S.	12 E.	?	Young, B.M. unpub., 1918.
37	Isom Ranch deposit.....	Dave Isom (O).....	3 $\frac{1}{2}$ miles NE. of Edna	.....	.....	?	Allen, B.M., vol. 37, p. 162, 1941.
8	Jasper.....	.....	31	30 S.	12 E.	?	Young, B.M. unpub., 1918.
39	Johney.....	T. H. Keys (O).....	32	28 S.	11 E.	C?	Ireland, D.M., S.M.R. X, p. 583, 1890
	Johney Ranch.....	Geo. M. Johney (O).....	2	31 S.	11 E.	?	Young, B.M. unpub., 1918. Logan, D.M. Bull. 76, p. 170, 1918.

35	Johnson Ranch deposit.....	Mrs. R. F. Johnson (O).....	N $\frac{1}{2}$ 10	30 S.	12 E.	C?	Young, B.M. unpub., 1918.
25	Lador.....	-----	32	29 S.	12 E.	?	Ireland, D.M., S.M.R. X, p. 582, 1890
19	Letter.....	-----	29	29 S.	12 E.	C	Young, B.M. unpub., 1918.
36	Low Ranch.....	Jack Low (O).....	19	30 S.	13 E.	C?	Young, B.M. unpub., 1918.
	Luchessa Ranch.....	A. Luchessa (O).....	N. side of San Simcon Creek, 2 miles from mouth			C?	Young, B.M. unpub., 1918.
36	Lucky Strike.....	H. Mohlman (O).....	19	30 S.	13 E.	C?	Young, B.M. unpub., 1918.
9	Mabel G.....	Lewis Foundation Corp. (O).....	3 miles NW. of Morro; E. of State Hwy. No. 1			C	Young, B.M. unpub., 1918.
23	Mescal.....	-----	SE $\frac{1}{4}$ 29	29 S.	12 E.	B?	Smith and Griggs, G.S. Bull. 945-B, p. 36, 1944.
7	Middleman Ranch.....	W. C. and L. E. Middleman (O).....	25	28 S.	10 E.	C	Allen, D.M., vol. 37, pp. 161-162, 1941. Smith and Griggs, G.S. Bull. 945-B, p. 44, 1944.
12	Moonbeam No. 1.....	-----	NE $\frac{1}{4}$ SE $\frac{1}{4}$ 30	28 S.	11 E.	-----	Young, B.M. unpub., 1918.
16	Mountain View.....	E. Cacia (O).....	12	29 S.	11 E.	?	Allen, D.M., vol. 37, p. 141, 1941.
34	New London (London).....	Mrs. Grace Thornberg (O).....	SW $\frac{1}{4}$ 23	29 S.	11 E.	?	Young, B.M. unpub., 1918.
	-----	Castro Chrome Associates (S)	SW $\frac{1}{4}$ SE $\frac{1}{4}$ 33	29 S.	12 E.	A	Smith and Griggs, G.S. Bull. 945-B, pp. 41-42, 1944.
24	Niggerhead.....	-----	NE $\frac{1}{4}$ 32	29 S.	12 E.	C?	Logan, D.M. Bull. 76, pp. 171-173, 1918.
15	Norcross (Bingani) mine.....	B. Biaggini Estate (O).....	NE $\frac{1}{4}$ 13	29 S.	11 E.	A	Young, B.M. unpub., 1918. Allen, D.M., vol. 37, pp. 162-163, 1941.
	-----	-----	1 $\frac{1}{4}$ miles NE. of Morro; 1 mile N. of county road			C?	Allen, D.M., vol. 37, p. 162, 1941. Smith and Griggs, G.S. Bull. 945-B, pp. 37-38, 1944.
5	Ocean View.....	Pete Quintana (O).....	10 miles E. of Cambria; on North Fork of Santa Rosa Creek 1 mile from main stream			?	Logan, D.M. Bull. 76, p. 174, 1918. Allen, D.M., vol. 37, p. 143, 1941.
30	Old Timer: See Pine Mountain claims.....	C. L. Seeley and G. Miller (O).....	NW $\frac{1}{4}$ 35	29 S.	12 E.	?	Young, B.M. unpub., 1918.
27	Ore Bag (Mutual ?).....	C. L. Seeley and G. Miller (O).....	SW $\frac{1}{4}$ 26	29 S.	12 E.	?	Young, B.M. unpub., 1918.
	Outpost (Old Glory).....	-----	SW $\frac{1}{4}$ 27	29 S.	12 E.	?	Young, B.M. unpub., 1918.
	Peppard Ranch.....	M. T. Peppard (O).....	10 miles E. of Cambria; on North Fork of Santa Rosa Creek 1 mile from main stream			?	Young, B.M. unpub., 1918.
	Percira claims.....	J. and P. Percira (O).....	3 to 4 miles N. of Pine Moun- tain to T. 25 S., R. 8 E.			C?	Logan, D.M. Bull. 76, p. 176, 1918.

TABLE 3. ALPHABETICAL LIST, BY COUNTIES, OF CHROMITE DEPOSITS
IN THE SOUTHERN COAST RANGES OF CALIFORNIA—Continued.

San Luis Obispo County—Continued

Map number ^a (Pl. 4)	Property ^b	Owners or shippers ^c	Location ^d			Class by produc- tion ^e	Source of data ^f
			Section	Town- ship	Range		
32	Pick and Shovel (Safety)-----	Mrs. Grace Thornberg (O)-----	SE $\frac{1}{4}$ 34	29 S.	12 E.	A	Smith and Griggs, G.S. Bull. 945-B, p. 40, 1944. Logan, D.M. Bull. 76, pp. 174-175, 1918. Allen, D.M., vol. 37, p. 163, 1941.
5	Pine Mountain claims (Chisholm and Old Tinner mines) Porta Bros. Ranch-----	Mrs. P. A. Hearst (O)----- Porta Bros. (O)-----	3, 10	26 S.	8 E.	C?	Young, B.M. unp., 1918.
3	Rancho Piedra Blanca----- Rancho Santa Rita-----	Mrs. P. A. Hearst (O)----- F., G., and C. Juhl (O)-----	4 miles from mouth of San Simeon Creek, $\frac{3}{4}$ mile N. of creek	4 | 25 S. | 7 E. 9 miles N.E. of Cayucos on Cayucos-Cambria road		?	Logan, D.M. Bull. 76, p. 176, 1918. Young, B.M. unp., 1918.
23 25	Raville----- Rodilla----- Rogers Ranch-----	----- ----- G. E. and C. H. Rogers (O)-----	29 | 29 S. | 12 E. 32 | 29 S. | 12 E.			C? ?	Allen, D.M., vol. 37, p. 161, 1941. Ireland, D.M., S.M.R. X, p. 582, 1890. Young, B.M. unp., 1918.
2	Rogers San Carpojarro Creek deposits-----	G. E. and C. H. Rogers (O)-----	N. side of San Simeon Creek, 2 miles from mouth	5, NW $\frac{1}{4}$ 4	25 S.	?	Young, B.M. unp., 1918.
1 4	Russ deposit----- San Carpojarro Creek deposits (Arroyo La Cruz, Owl No. 1 and Owl No. 2)-----	Antone D. Russ (O)----- F. J. Estrado and C. M. Garcia (O)-----	4 | 25 S. 12 | 25 S.			?	Logao, D.M. Bull. 76, p. 177, 1918. Logan, D.M. Bull. 76, p. 177, 1918. Young, B.M. unp., 1918.
24 31	Santa Clara----- Single Jack-----	Mrs. Grace Thornberg-----	N $\frac{1}{2}$ 33 NE $\frac{1}{4}$ 34	29 S. 29 S.	12 E. 12 E.	?	Allen, B.M., vol. 37, p. 162, 1941.
	Sousa Ranch-----	Virginia L. Sousa (O)----- T. B. Elliot (S)-----	3 miles SW. of San Luis Obispo			C?	Smith and Griggs, G.S. Bull. 945-B, p. 41, 1944. Young, B.M. unp., 1918.

13	Stadlight. Steele Ranch (Rancho Santa Manuela)	Mrs. Susie Steele (O)	13 | 29 S. | 11 E. 7 miles NE. of Arroyo Grande	?	Allen, D.M., vol. 37, p. 142, 1941. Young, B.M. unpub., 1918. Logan, D.M. Bull. 76, p. 176, 1918.
13	Sunrise No. 1		13 | 29 S. | 11 E.	?	Allen, D.M., vol. 37, p. 142, 1941.
15	Sunrise No. 2		13 | 29 S. | 11 E.	?	Allen, D.M., vol. 37, p. 142, 1941.
33	Sunshine claims (Alviso, Keeney)		S½ 34 | 29 S. | 12 E.	C?	Allen, D.M., vol. 37, p. 142, 1941. Young, B.M. unpub., 1918.
11	Sweetwater (San Juan)	W. W. Pierce (O)	SE¼ 11 | 29 S. | 11 E.	A	Logan, D.M. Bull. 76, p. 167, 1918. Smith and Griggs, G.S. Bull. 945-B, pp. 36-37, 1944. Logan, D.M. Bull. 76, pp. 177-178, 1918. Young, B.M. unpub., 1918.
11	Tip Top	W. W. Pierce (O)	12 | 29 S. | 11 E.	?	Allen, D.M., vol. 37, p. 140, 1911.
26	Trinidad (La Trinidad)	S. L. Swartz (O)	NE¼ 33 | 29 S. | 12 E.	A	Allen, D.M., vol. 37, p. 141, 1941. Smith and Griggs, G.S. Bull. 945-B, pp. 38-40, 1944. Logan, D.M. Bull. 76, p. 71, 1918. Young, B.M. unpub., 1918.
15	Victory No. 3 (Sunrise No. 3, Bernardo No. 3 or Manzanita)	L. A. Moran, J. A. Houlihan and E. C. Cazier (O)	13 | 29 S. | 11 E.	A?	Allen, D.M., vol. 37, p. 163, 1941. Smith and Griggs, G.S. Bull. 945-B, p. 38, 1944. Young, B.M. unpub., 1918.
10	Vulture	J. Barneberg (O)	NW¼ 2 | 29 S. | 11 E.	?	Allen, D.M., vol. 37, pp. 142-143, 1941.
40	Welch Ranch	Joseph C. Welch (O)	4 | 31 S. | 11 E.	?	Young, B.M. unpub., 1918.
15	West Norcross (Brooklyn)	J. A. Houlihan and E. C. Cazier (O)	13 | 29 S. | 11 E.	B?	Logan, D.M. Bull. 76, p. 178, 1918. Smith and Griggs, G.S. Bull. 945-B, p. 38, 1944. Young, B.M. unpub., 1918.
6	Wheeler claims	James Wheeler and associates (O)	4 to 7 miles S. of Santa Mar- garita	?	Allen, D.M., vol. 37, p. 143, 1941. Logan, D.M. Bull. 76, p. 178, 1918.
	Zerfing Ranch (Old Creek) de- posits	A. L. Zerfing (O)	SE¼ SE¼ 24 | 28 S. | 10 E.	C	Smith and Griggs, G.S. Bull. 945-B, p. 41, 1944. Young, B.M. unpub., 1918. Logan, D.M. Bull. 76, p. 178, 1918.

TABLE 3, ALPHABETICAL LIST, BY COUNTIES, OF CHROMITE DEPOSITS
IN THE SOUTHERN COAST RANGES OF CALIFORNIA—Continued.

Santa Barbara County

Map number ^a (Pl. 5)	Property ^b	Owners or shippers ^c	Location ^d			Class by produc- tion ^e	Source of data ^f
			Section	Town- ship	Range		
5	Acachuma: See Fairview Ancient Chrome. Bacon (O and B) mine.	L. W. Hopper and Sid Stewart. J. F. Bacon (O) James O'Donnell and Robert Byrne (S)	7 NW ¼ 7	6 N. 7 N.	31 W. 29 W.	D B	Logan, D.M. Bull. 76, p. 179, 1918. Young, B.M. unpub., 1918.
3	Bull Run.	F. S. Smith, Joe Whitehorst (O)	5?	7 N.	29 W.	D	Young, B.M. unpub., 1918.
6	Chicken Spring claim.	C. E. Lee and Associates (O)	15	7 N.	29 W.	?	
8	Engle Fairview. La Laguna Ranch: See Monti- nero	C. E. Lee and Associates (O) C. E. Lee and Associates (O)	10 15	7 N. 7 N.	29 W. 29 W.	D C	Young, B.M. unpub., 1918. Young, B.M. unpub., 1918.
4	Los Olivos: See Fairview Mesa claim. Montinero prospect.	James O'Donnell and Robert Byrne (S)	8 S center 1	7 N. 7 N.	29 W. 30 W.	? C?	Young, B.M. unpub., 1918.
7	Peacock Chrome. Point Sal. Roberts claims.	F. C. Ontiveros (O) H. L. Roberts and Nelson Tay- lor (O)	? 1 29? 8, 15 7 N., 32 32 E ½ SW ¼ 31 15	7 N. 9 N. 8 N. 7 N. 8 N. 8 N. 8 N.	29 W. 36 W. 29 W. 29 W. 29 W. 29 W. 30 W.	B D C D ? C	Everhart, D.M., vol. 46, pl. 74, 1950. Ireland, D.M., S.M.R. X, p. 601, 1890. Huguenin, D.M., S.M.R. XV, p. 735, 1917.
2	Red Bluff claim.	Utah E. Smith (O)					
1	Scribb Oak claim. Zaca Lake.	L. Davis (O)					Young, B. M. unpub., 1918.

TABLE 3. ALPHABETICAL LIST, BY COUNTIES, OF CHROMITE DEPOSITS
IN THE SOUTHERN COAST RANGES OF CALIFORNIA—Continued.

Santa Clara County

Map number ^a (Pl. 2)	Property ^b	Owners or shippers ^c	Location ^d			Class by production ^e	Source of data ^f
			Section	Town- ship	Range		
11	Bay Cities Water Co. Black Bird	H. F. Wiggins	S½ 24	8 S.	2 E.	C	Young, B.M. unpub., 1918.
		H. Bonetti (O)	? 26, 35	6 S.	4 E.	D	Young, B.M. unpub., 1918.
2	Bonetti Mine Ferraro Greenwalls property Hahn Ranch deposits	K. D. Winslip (O)	12	9 S.	2 E.	C	Young, B.M. unpub., 1918.
		T. B. Greenwalls (O)	? 9	9 S.	4 E.	C?	Crawford, D.M., S.M.I.R. XIII, p. 50, 1896.
		F. H. Tucker, H. E. Jones	? 9	8 S.	1 W.	C	Harder, G.S., M.R.U.S., p. 768, 1909.
				8 S.	1 E.	C	Ireland, D.M., S.M.I.R. VIII, p. 549, 1888.
12	Jens mine Kilday Ranch deposits	John Jen (O)	32	8 S.	1 E.	C	Logan, D.M. Bull. 76, p. 222, 1918.
		M. J. Kilday (O)	5	9 S.	1 E.	B	Logan, D.M. Bull. 76, p. 180, 1918.
13	Laurel Lake Ranch deposits.	J. A. Ferbrache (S)	20	10 S.	3 E.	B	Young, B.M. unpub., 1918.
							Logan, D.M. Bull. 76, p. 180, 1918.
10	Ramelli Western Magnesite Co. property.	Mary E. Ramelli (O)	E½ 23	8 S.	2 E.	C	Sampson, G.S., M.R.U.S., p. 15, 1922.
		W. Balkan (S)	4	6 S.	5 E.?	D	Young, B.M. unpub., 1918.
1	Winslip properties	K. D. Winslip Estate (O)	SW¼ 7	6 S.	5 E.		Logan, D.M. Bull. 76, p. 180, 1918.
			11, 12	6 S.	4 E.	B	Diller, J.S., M.R.U.S., pp. 606-607, 1921.
9	Yates Lease	M. Rigetti (S)	S½ 13	8 S.	2 E.	C	Young, B.M. unpub., 1918.
							Young, B.M. unpub., 1918.

TABLE 3, ALPHABETICAL LIST, BY COUNTIES, OF CHROMITE DEPOSITS
IN THE SOUTHERN COAST RANGES OF CALIFORNIA—Continued.

Stanislaus County

Map number ^a (Pl. 2)	Property. ^b	Owners or shippers ^c	Location ^d		Class by produc- tion ^e	Source of data ^f
			Section	Town- ship		
6	Adobe Canyon group (McGuire et al., or Mountain View and Gray Fox)	West Coast Chrome Co. (S)-----	SW $\frac{1}{4}$ 14 SE $\frac{1}{4}$ 15 NE $\frac{1}{4}$ 22	6 S.	5 E.	Hawkes, Wells, and Wheeler, G.S. Bull. 936-D, pp. 96-97, 1942.
3	Black Bart group-----	West Coast Chrome Co. (S)-----	16	6 S.	5 E.	Hawkes, Wells, and Wheeler, G.S. Bull. 936-D, pp. 98-101, 1942.
7	Black Bear mine-----	West Coast Chrome Co. (S)-----	Central 22	6 S.	5 E.	Hawkes, Wells, and Wheeler, G.S. Bull. 936-D, pp. 101-102, 1942.
4	Chrome Camp mine-----	Mineral Products Co. (S)-----	11	6 S.	5 E.	Hawkes, Wells, Wheeler, G.S. Bull. 936-D, pp. 103-104, 1942.
8	Hampton mine----- Lucky Girl mine-----	John Hampton et al. (O)----- West Coast Chrome Co. (S)-----	16 NW $\frac{1}{4}$ 22	6 S. 6 S.	5 E. 5 E.	Young, R.M., unpub., 1918. Logan, D.M. Bull. 76, p. 224, 1918.
5	No. 5 mine----- Platner-----	West Coast Chrome Co. (S)----- J. H. Platner (O)-----	14, 15 15	6 S. 6 S.	5 E. 5 E.	Hawkes, Wells, Wheeler, G.S. Bull. 936-D, pp. 97-98, 1942. Logan, D.M. Bull. 76, p. 205, 1918.

^a Map numbers correspond with those used on plates 1, 2, 3, 4, and 5.^b Most common name of property is listed with data; less common name is listed in parentheses following most common name, or is listed separately and cross referenced.^c List of abbreviations:

O—Owner(s)

S—Shipper(s)

G.S.—U. S. Geological Survey

R.M.—R. M. Bureau of Mines

D.M.—California Division of Mines

S.M.R.—Report of California State Mineralogist

M.R.U.S.—Mineral Resources of United States, U. S. Geological Survey

Bull.—bulletin

Vol.—volume

unpub.—unpublished

^d All township and range locations north of Santa Barbara County are based on the Mount Diablo meridian; those in Santa Barbara County are based on the San Bernardino meridian.^e Production classes:

A—1,000 long ton or more

B—150 to 1,000 long tons

C—less than 150 long tons

D—no ore shipped

^f List of authors of source data:

Allen, J. E.

Crawford, J. J.

Diller, J. S.

Eyerhart, D. L.

Frank, H. A.

Griggs, A. R.

Harder, E. C.

Hawkes, H. E., Jr.

Huganin, E.

Irdan, W.

Logan, C. A.

Rynatson, G. A.

Sampson, E.

Smith, C. T.

Wells, F. G.

Wheeler, D. P., Jr.

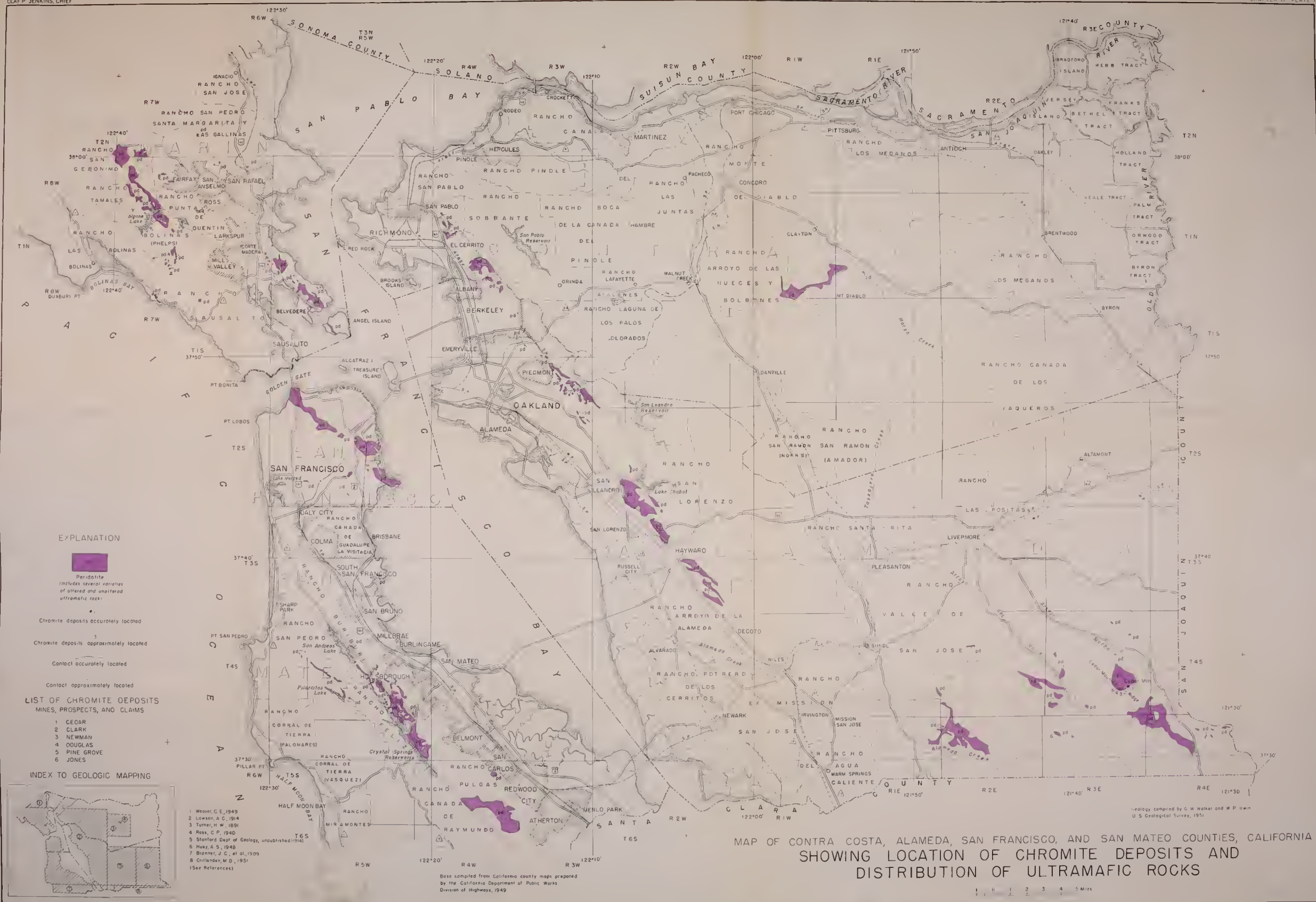
Young, E. L.



$121^{\circ}40'$ R. 3 E.

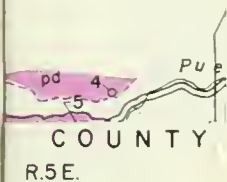
CISCO, AND SA
CHROMITE
ULTRAMAF

2 3 4 5 Miles



ATV OF
T

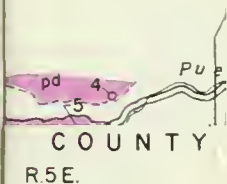
R.5 E.



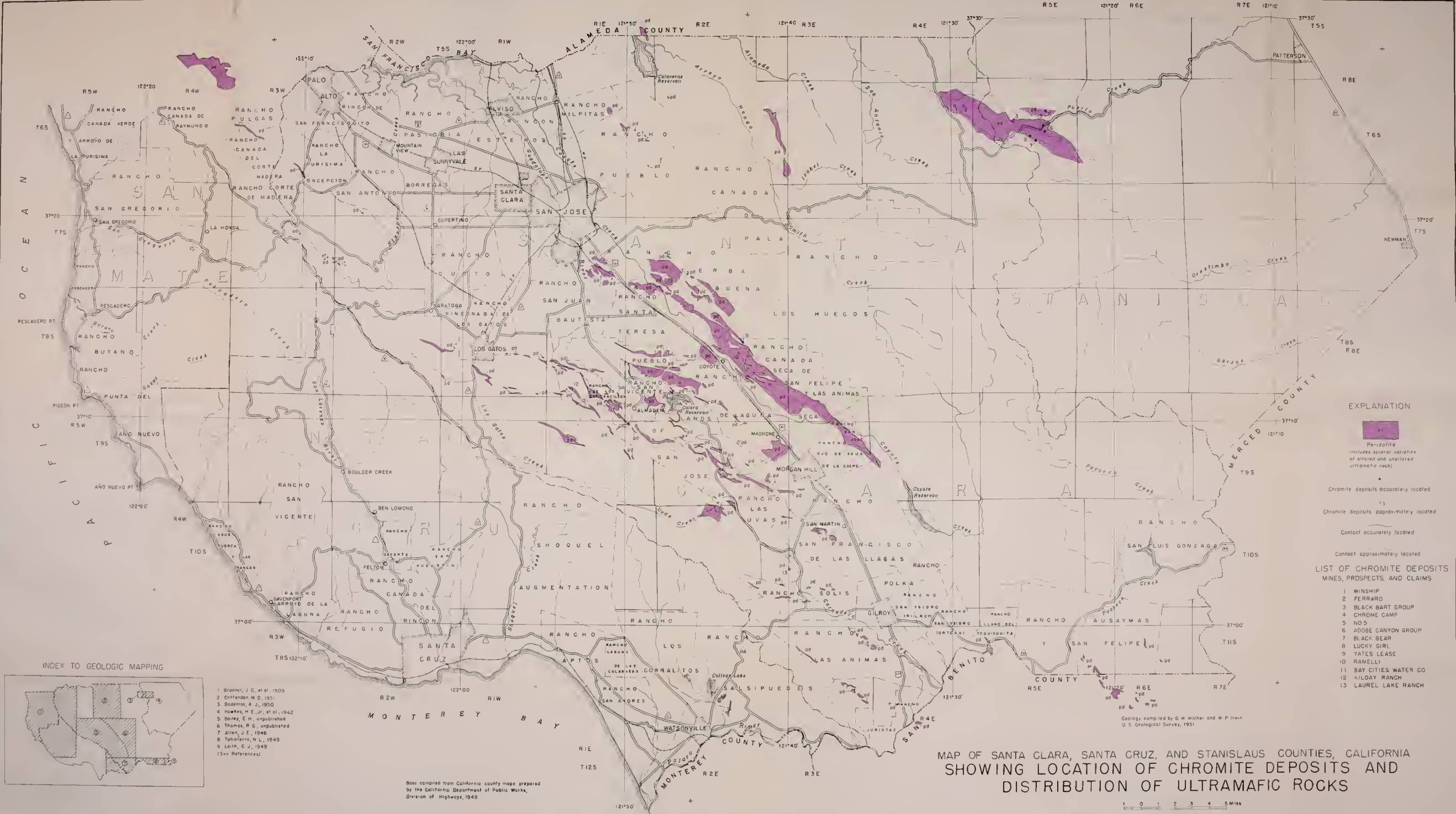
A CLARA,
LOCA
STRIBL

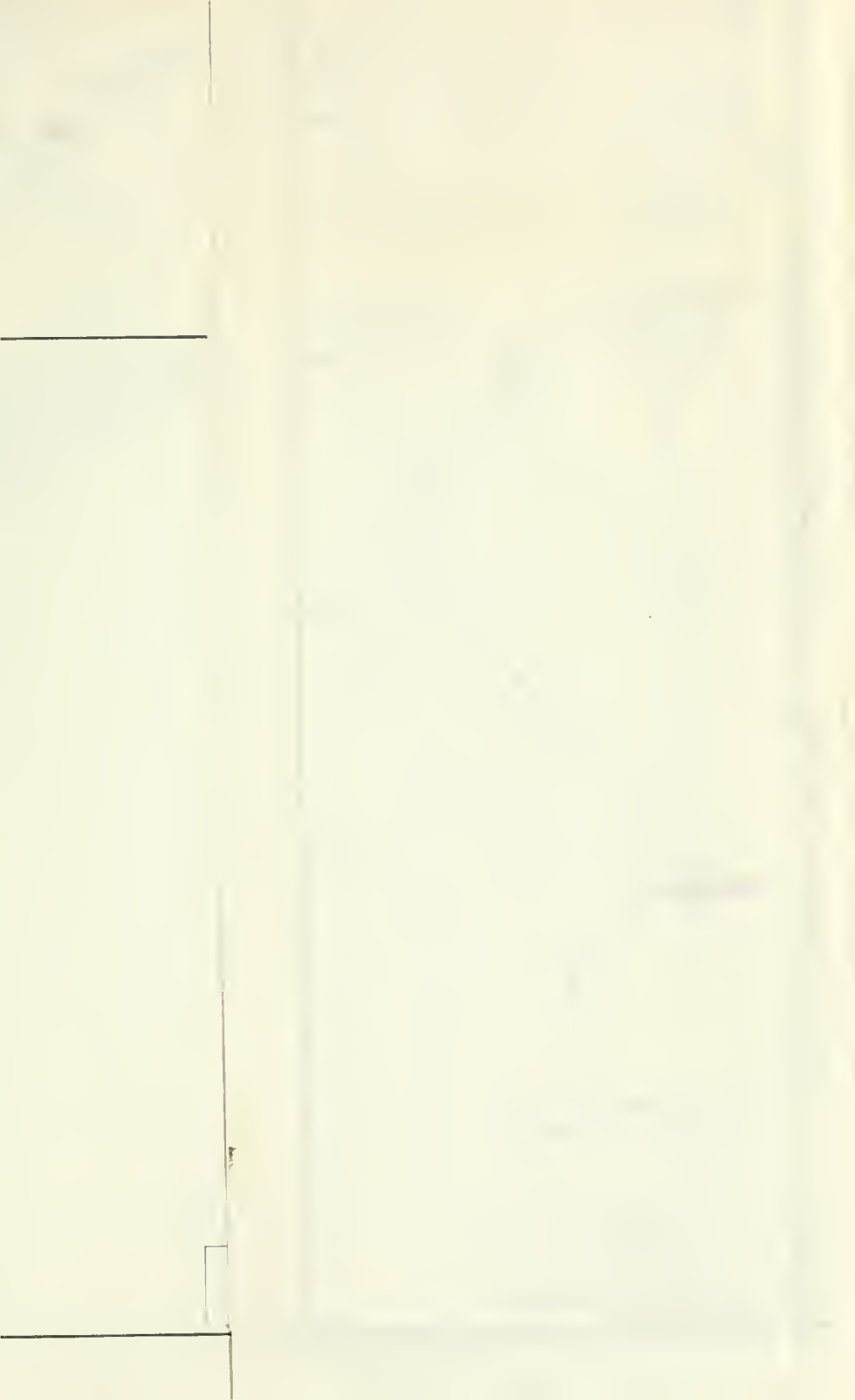
ATV OF
T

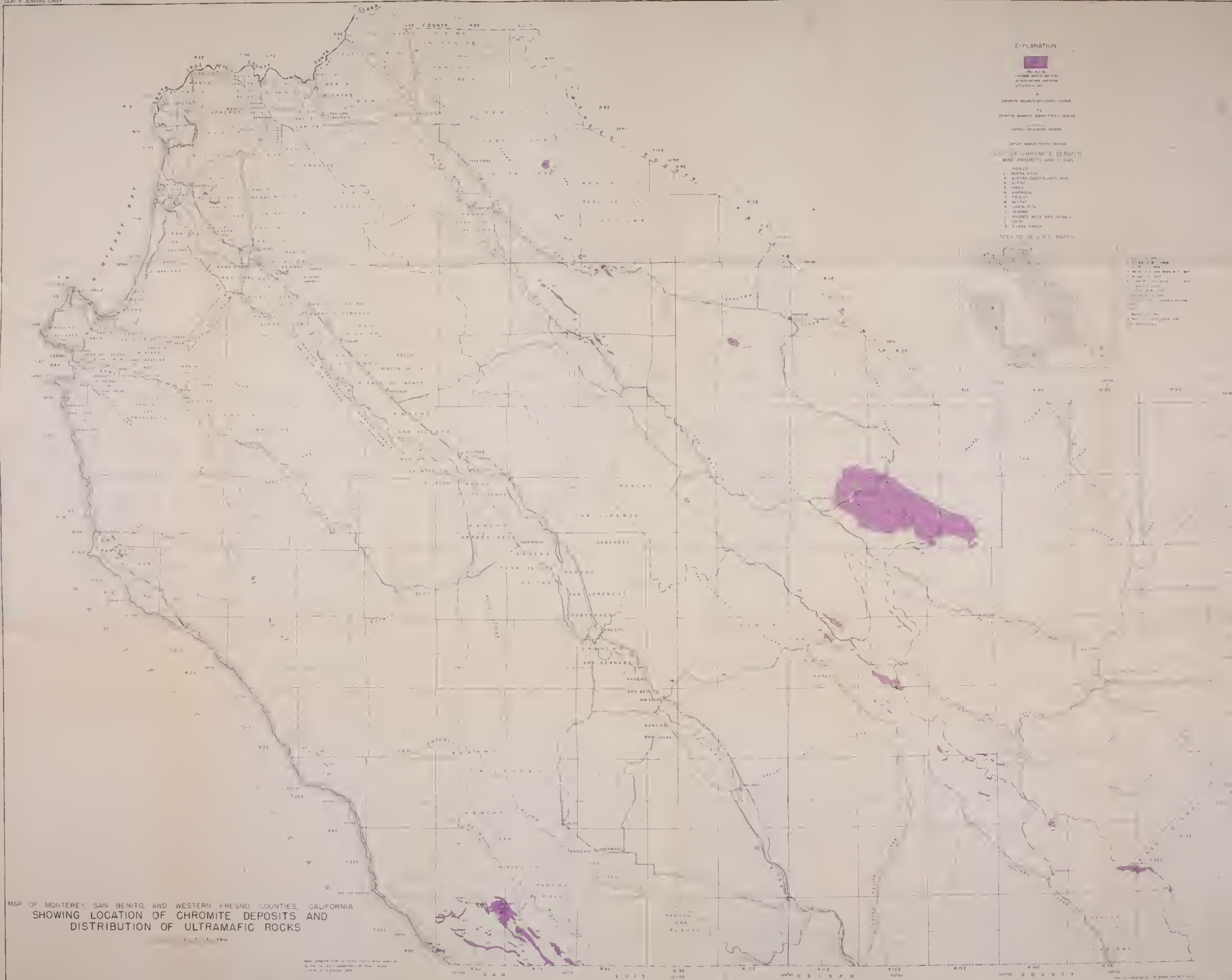
R.5 E.



A CLARA,
LOCA
STRIBL

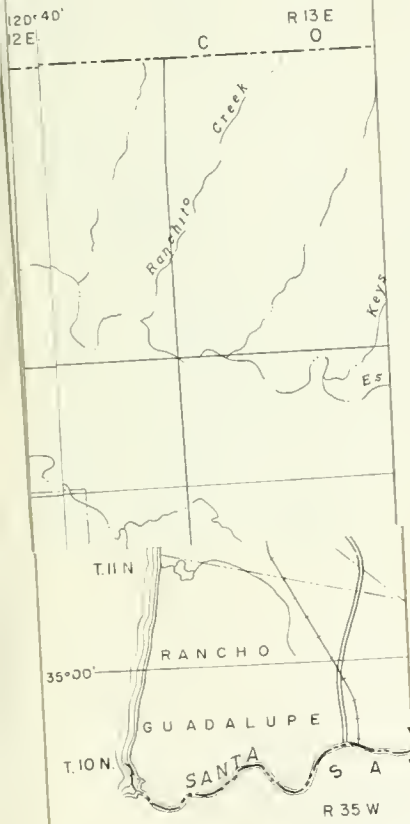






BULLETIN 134 - PART II
CHAPTER II - PLATE 4

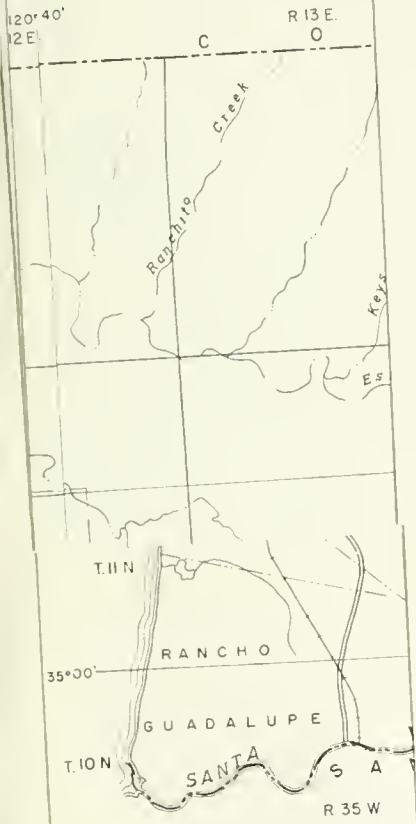
UNIT



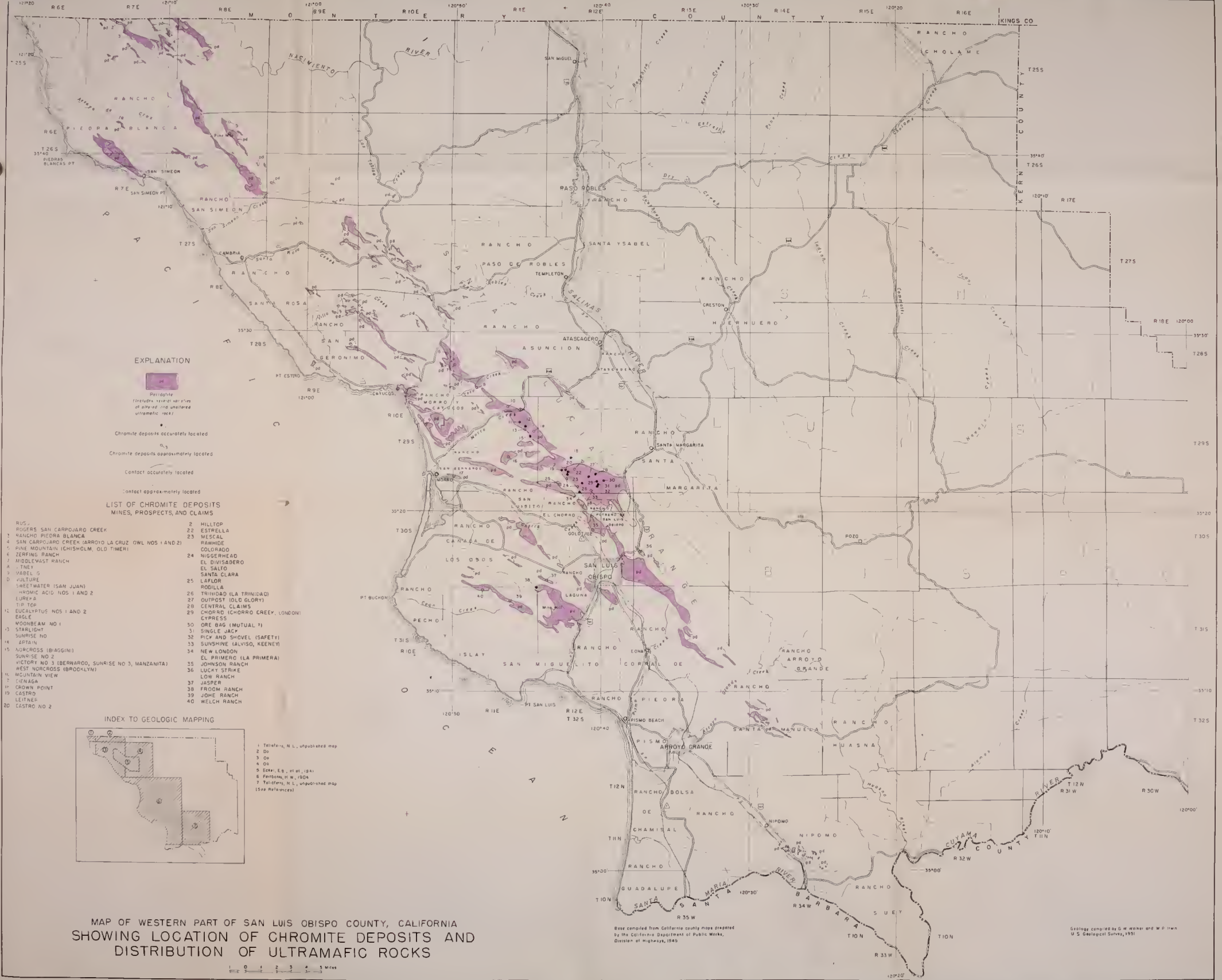
Base compiled from California county maps compiled by G. W. Walker and W. P. Irwin
by the California Department of Public Geological Survey, 1951
Division of Highways, 1949

BULLETIN 134 - PART II
CHAPTER II - PLATE 4

UNIT



Base compiled from California county maps compiled by G. W. Walker and W. P. Irwin
by the California Department of Public Geological Survey, 1951
Division of Highways, 1949



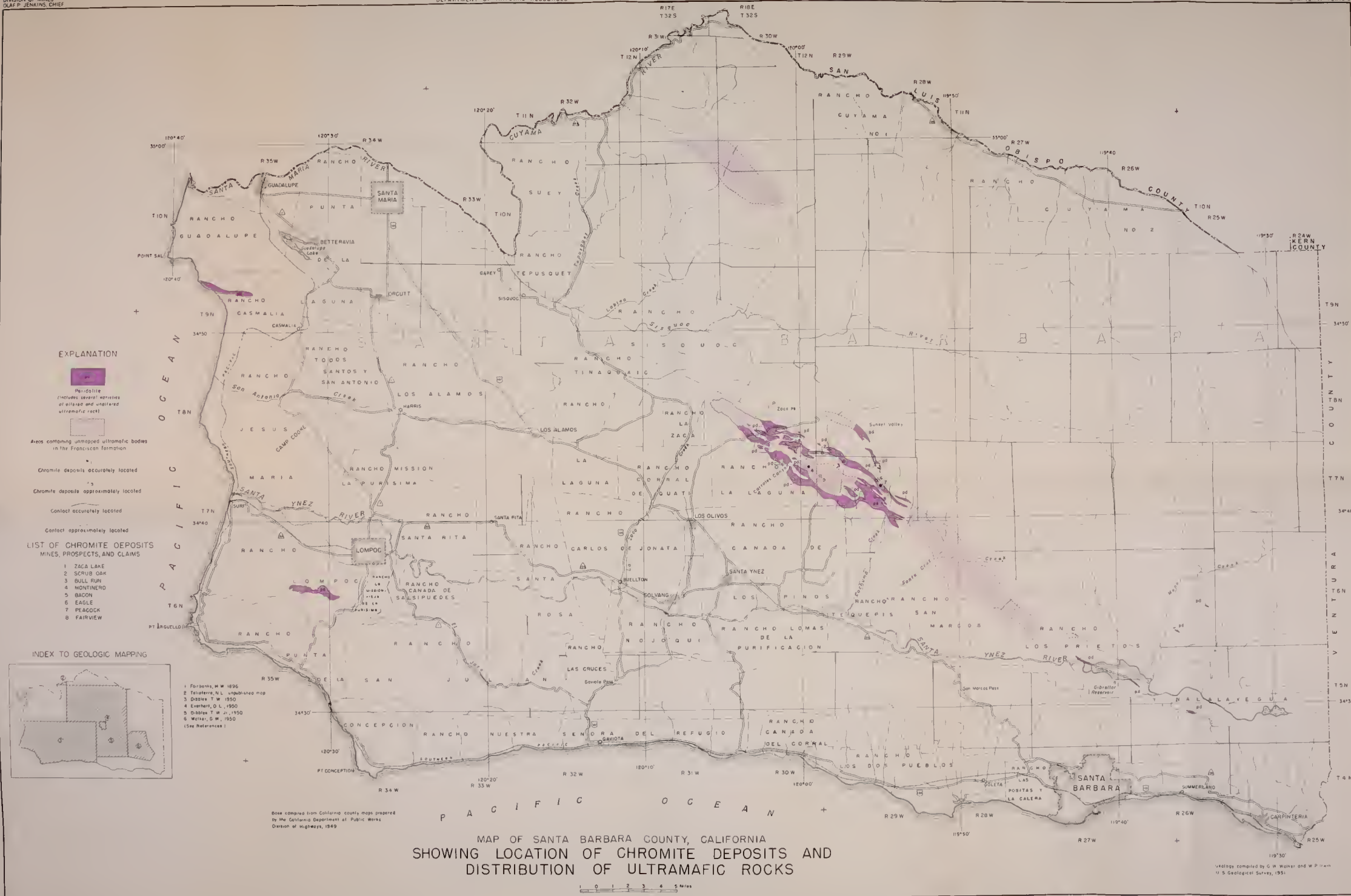
MAP OF WESTERN PART OF SAN LUIS OBISPO COUNTY, CALIFORNIA
SHOWING LOCATION OF CHROMITE DEPOSITS AND
DISTRIBUTION OF ULTRAMAFIC ROCKS

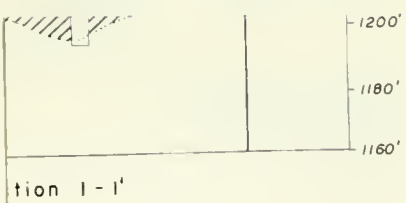
R17E.
T32S



R17E.
T.32S

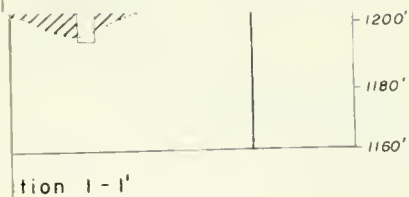






ES AT CALIFORNIA

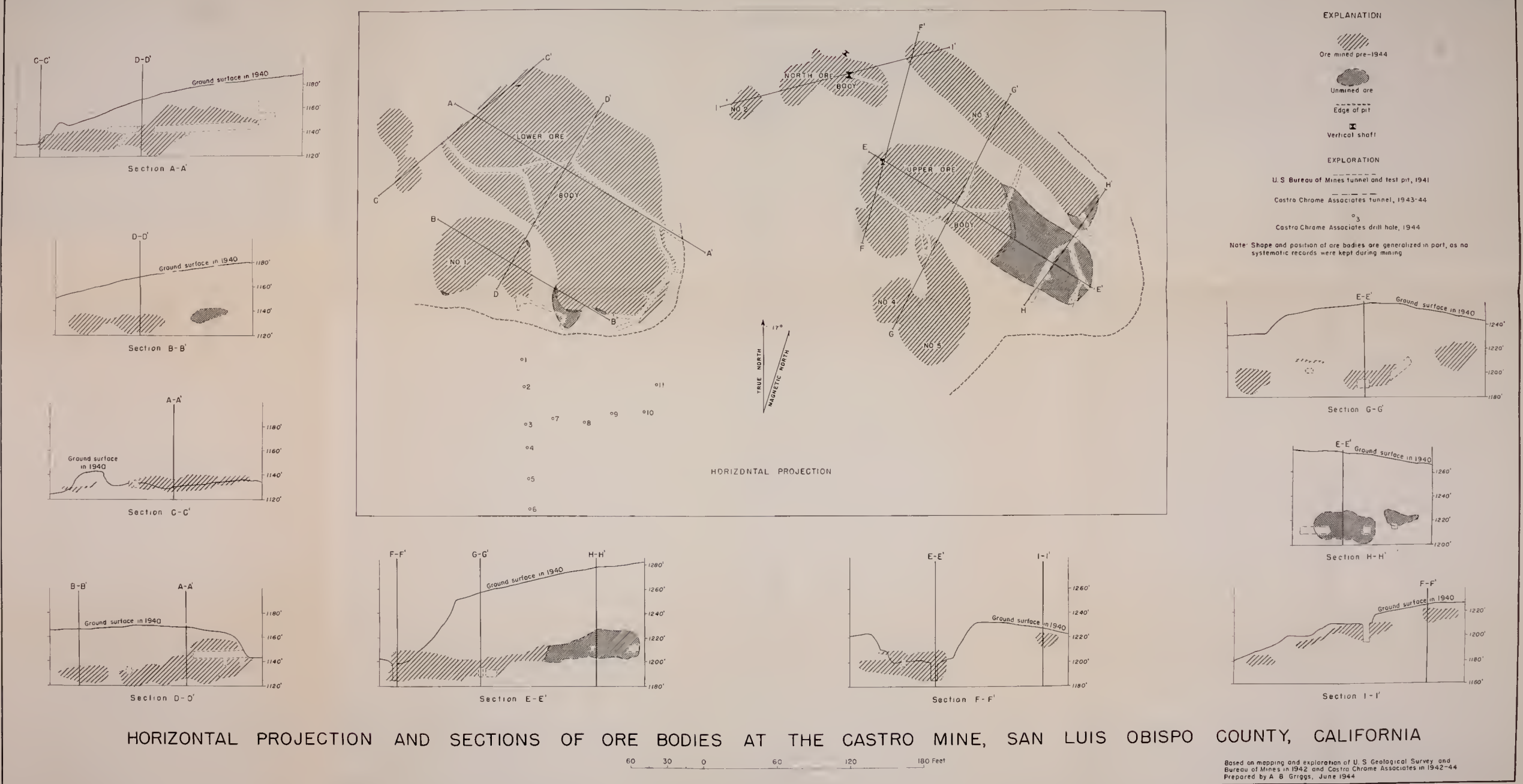
0 60 n of U. S. Geological Survey and
 Stro Chrome Associates in 1942-44.
 1944



ES AT CALIFORNIA

0 60

on of U. S. Geological Survey and
stro Chrome Associates in 1942-44.
1944



DIVISION OF MINES
OLAF P. JENKINS,

BULLETIN 134 - PART II
CHAPTER II - PLATE 7

550

Geology and topography by C. T. Smith
and A. B. Griggs, 1940
Underground workings by A. B. Griggs,
June 1944

TY, CALIFORNIA

DIVISION OF MINES
OLAF P. JENKINS,

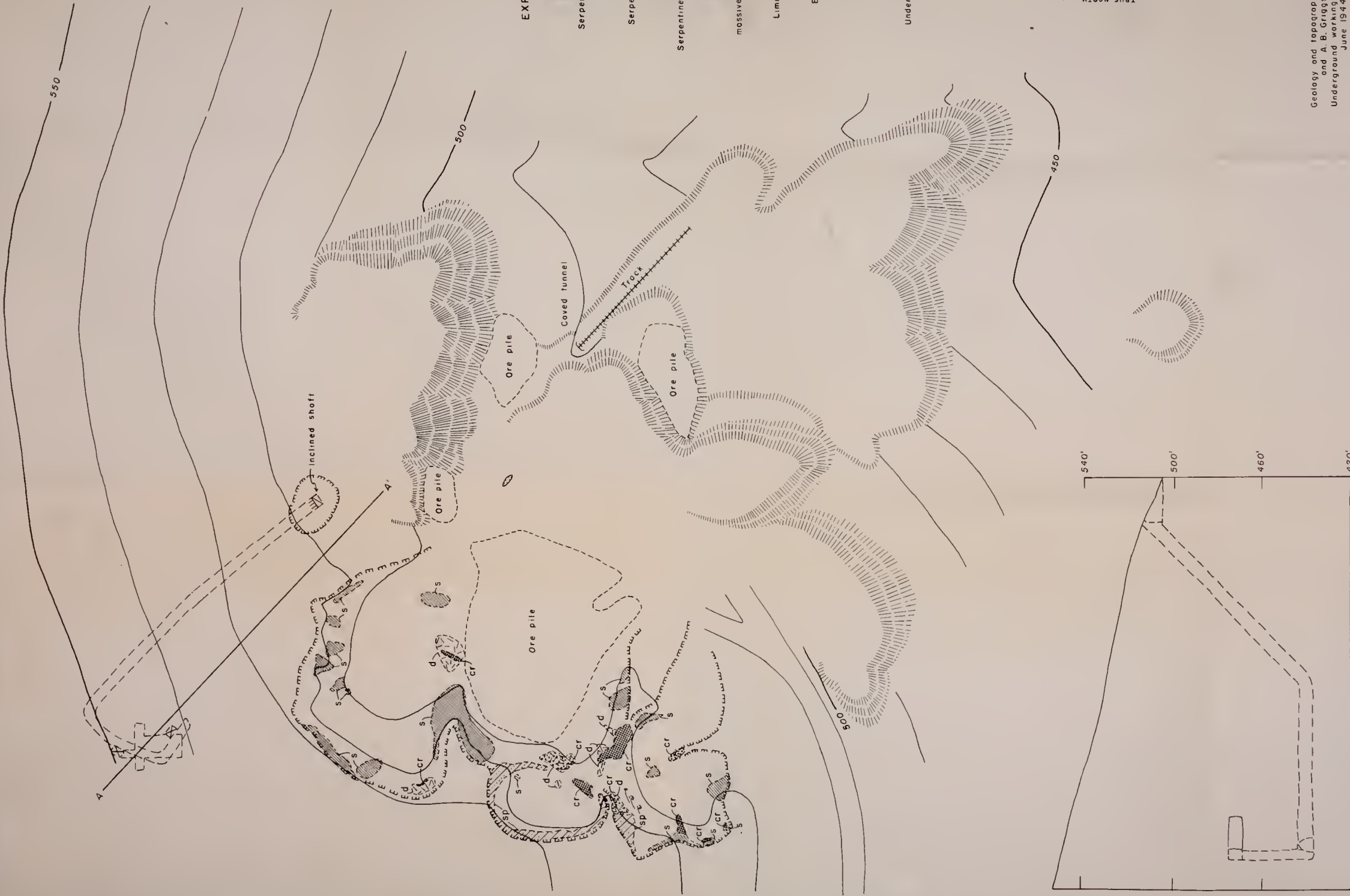
RIOR

BULLETIN 134 - PART II
CHAPTER II - PLATE 7

550

Geology and topography by C.T. Smith
and A.B. Griggs, 1940
Underground workings by A.B. Griggs,
June 1944

TY, CALIFORNIA



Geology and topography by C. T. Smith
and A. B. Griggs, 1940
Underground workings by A. B. Griggs,
June 1944

MAP AND SECTION OF THE TRINIDAD MINE, SAN LUIS OBISPO COUNTY, CALIFORNIA



EXPLANATION	
SEDIMENTARY ROCKS	IGNEOUS ROCKS
Qal	g
Recent stream deposits	Gabbro
Qcs	py
Calcareous sinter	Pyroxenite
hc	d
Chico formation	Dunite
jl	pd
Franciscan formation	Peridotite
	Magnetite veins
	Chromite mine
	Chromite prospect
	Quicksilver mine
	Quicksilver prospect
	Slide
	Trail
	Overhead tram
	Railroad

GEOLOGIC MAP OF THE ULTRAMAFIC COMPLEX OF THE RED MOUNTAIN-DEL PUERTO AREA
SANTA CLARA AND STANISLAUS COUNTIES, CALIFORNIA

Compiled from published maps by Howkes, et al (1942, pl 10)
and by Badenas (1950, pl. 36)

THIS BOOK IS DUE ON THE LAST DATE
STAMPED BELOW

BOOKS REQUESTED BY ANOTHER BORROWER
ARE SUBJECT TO IMMEDIATE RECALL

JUN 30 2002

JUN 30 2003

RECEIVED

APR 26 2003

PSL

LIBRARY, UNIVERSITY OF CALIFORNIA, DAVIS

<http://libnte.ucdavis.edu/PatronRenew.html>

Automated Phone Renewal (24-hour): (530) 752-1132

D4613 (4/99)M

Nº 684745

California. Division
of Mines and Geology.

Bulletin. (----.:
Geological investiga-
tions of chromite in
California)

TN24

C3

A3

no.134:1

PHYSICAL
SCIENCES
LIBRARY

LIBRARY

Call Number:

684745

California. Division
of Mines and Geology.

Bulletin. (----.:
Geological investi-

TN24

C3

A3

no.134:1



